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THE CALIFORNIA MACKEREL
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By
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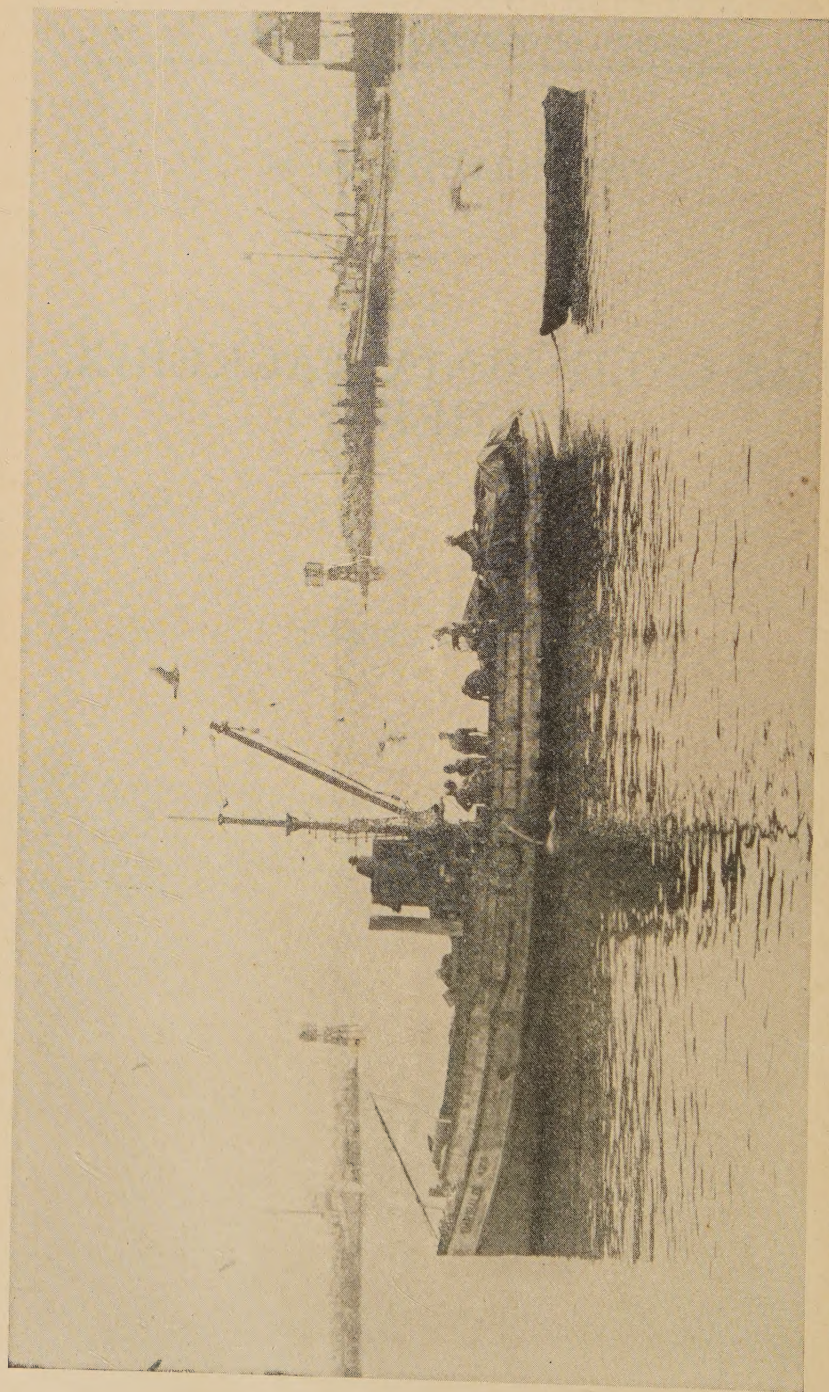


FIG. 1. San Pedro cannery mackerel boat—Japanese ring netter. This boat is 54 feet long, powered with a 50-horsepower gasoline engine and carries a crew of 10 men. Photograph by author, December, 1931.

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The California Mackerel Fishery

By RICHARD S. CROKER

I. THE MACKEREL, A WORLD-WIDE FOOD FISH

WIDESPREAD IMPORTANCE OF THE MACKEREL

General

The word mackerel is a common one in every day conversation. Everywhere we can hear such expressions as, "holy mackerel," "dead as a mackerel," and "cold as a mackerel." Undoubtedly the fish called mackerel, from which these terms have arisen, must be universally popular and well known. It is hoped that the following pages will give some idea of the popularity and economic importance of this fish.

We have all seen the beautiful cloud effect known as "mackerel sky" that presages unsettled weather. The clouds were given the name because they duplicate, both in form and color, the wavy stripes of the mackerel. But perhaps there is a deeper significance in the name, some realization of the similarity between the unsettled conditions that always prevail in the mackerel fishery and the clouds that may either turn to rain or give way to sunshine.

The irregular habits and the unheralded periods of scarcity or abundance of the common Atlantic mackerel are subjects of great concern to the fishermen of Europe and America. The occasional failure of the mackerel to appear spells hardship and privation for many fishermen and dealers, and when it does appear in the vast shoals that are eagerly awaited each spring, adverse economic conditions sometimes prevent the fishermen from making a living. In California the mackerel is always present, summer and winter, year in and year out, but because of economic factors the fishery is subject to sudden ups and downs. Throughout the world the mackerel fishery can be likened to the mackerel sky—nobody knows what it will be like tomorrow.

As might be expected, the habits of the Atlantic mackerel have long been the subject of speculation and study, both by fishermen and scientists. Many stories are current about how the mackerel spends the winter, the time when it is absent from the Atlantic coasts of Europe and North America. One of the most common stories is that the fish bury themselves in the mud at the bottom of the sea and that during this hibernation a film comes over their eyes so they are rendered blind. Some people claim that the mackerel go into the Arctic Ocean to spend the winter; others say that they go south into the tropics. The only certain fact is that nobody really knows where the majority of the mackerel spend the winter and that one guess is as good as another.

Mackerel occasionally appear in shoals so dense and extensive that the ocean is colored with them for miles. At these times it is said to be dangerous to enter the water. A story is told of a Norwegian fisherman who fell overboard into a school of mackerel and was torn to pieces by the savage fish before his comrades could pull him out. This story is probably somewhat exaggerated, but the thought of that luckless fellow would suffice to keep most people from diving into a swarm of hungry mackerel.

The idea has arisen in some places, notably Australia, that the flesh of the mackerel and mackerel-like fishes is poisonous. As a matter of fact, no food is more wholesome than fresh or properly preserved mackerel, tuna or bonito. However, all these fish spoil readily if not cared for, and stale fish can cause illness, and the illness can cause stories about poison. One story would have us believe that the rays of the full moon shining on mackerel affect the flesh so as to make it highly poisonous. That story can be discounted. I would personally prefer to subject mackerel to moon rays than to the glare of the sun, which actually does cause all fish, not only mackerel, to spoil.

Economic Importance

The scombroid or mackerel-like fishes are of very great commercial importance throughout the world. The four most important groups of fishes are those comprising the herring, salmon, codfish and mackerel families. Of the mackerel family, the two mackerels (*Scomber* and *Pneumatophorus*) are among the most widespread and universally important, although the tunas, bonitos, seerfishes, and Spanish mackerels help to keep the family Scombridæ in a leading position.

The fishermen of nearly every maritime nation in the temperate zones catch mackerel in large numbers. The annual catch (1928-1929) off the North Sea and Atlantic coasts of Europe amounts to 100,000,000 pounds. The fishermen of the Atlantic coast of North America catch 40,000,000 to 60,000,000 pounds of mackerel every year (1924-1930). The California fishery accounts for 15,000,000 to 60,000,000 pounds annually (1928-1931). Japan, with an annual (1923-1925) catch of about 150,000,000 pounds, is the largest consumer of mackerel in the world. In addition to the foregoing, there are important mackerel fisheries in the Mediterranean and Black seas, and lesser fisheries in Australia, New Zealand and South America. The yearly landings for most of the countries where mackerel are caught are given in Table 1.

The mackerel is everywhere primarily a fresh fish, that is to say, the greatest part of the world catch is consumed in a fresh state. Nevertheless, really enormous quantities are canned, salted or dried in many parts of the world. The canning industry is a recent development, dating back no farther than the nineteenth century. Salting and drying, however, are ancient methods of preserving fish so they can be sent to distant markets or held over from periods of abundance to times of scarcity. Before modern refrigeration methods made possible the transportation or holding of fresh mackerel in quantities, salted mackerel was by far the most important product of the world's mackerel fishery.

TABLE 1
The World Mackerel Catch by Countries, in Thousands of Pounds (000 omitted)

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
California.....	2,450	2,766	2,690	2,276	3,980	2,978	3,235	3,610	4,729	35,251	57,974
Japan.....	121,277	111,096	116,875	120,167	148,128	150,276	166,815	x	x	x	x
East Coast, U. S. A.....	9,991	13,292	6,924	8,798	23,391	18,237	33,953	47,126	41,999	30,984	46,166
Canada.....	23,010	14,200	14,560	95,155	14,040	21,450	18,785	11,570	15,860	12,415	15,210
Sweden.....	16,045	15,692	11,301	12,632	12,830	11,316	12,229	13,210	9,557	9,720	10,930
Norway.....	14,134	14,736	15,302	17,233	21,896	16,814	12,987	17,396	20,157	16,986	15,417
Denmark.....	4,825	5,212	5,439	5,342	9,583	5,853	9,403	7,485	7,983	11,323	10,467
Poland.....	x	x	791	1,878	829	1,129	2	1,089	9	51	77
Germany.....	801	1,658	2,632	1,684	1,149	2,385	979	1,263	2,811	2,641	2,476
Holland.....	4,667	4,312	3,632	3,028	26,407	23,812	1,702	1,794	3,611	3,348	5,084
England.....	24,266	36,700	33,043	30,238	2,910	3,635	21,142	18,724	16,462	15,397	14,766
Scotland.....	5,364	7,809	6,023	4,766	7,187	8,885	4,575	3,589	4,398	3,806	6,508
Ireland.....	52,150	31,671	22,004	18,644	26,275	30,053	19,553	13,655	21,160	9,612	10,750
France.....	27,630	29,341	35,754	30,869	x	x	36,519	39,288	33,805	26,614	27,357
Belgium.....	x	571	x	x	x	x	17,079	x	x	217	1,175
Spain.....	x	x	15,653	x	x	x	x	x	x	16,481	x
Portugal.....	x	x	x	x	x	x	x	x	89	338	129

California and Japanese landings consists of *Pneumatophorus* sp.; all others are *Scomber scombrus*. California, Japan and Canada include only fish caught in home waters; all other nations from 1919 to 1927, inclusive, include landings from domestic and foreign waters; and 1928 and 1929 include landings of each nation's boats at home and abroad. Spain and France do not include landings at Mediterranean ports.

For sources, see references, page 17.

x denotes no statistics available.

----- denotes no mackerel caught.

THE SPECIES OF MACKEREL

Several species of mackerel, representing two genera (*Scomber* and *Pneumatophorus*) are the subjects of the world's mackerel fishery.

Scomber scombrus is the species most often caught in Europe and along the Atlantic coast of North America. The common names for this species, in use in the various countries where this fish is of commercial importance, are given in the following list:

Country	Common names
British Isles.....	Mackerel, Common Mackerel
Canada.....	Mackerel, Common Mackerel
Denmark.....	Makrel
Finland.....	Makrilli
Flanders.....	Makreel
France.....	Maquereau
Germany.....	Makrele
Holland.....	Makreel
Iceland.....	Makrill
Italy.....	Scombro, Scombro Comune
Jugoslavia.....	Lokarda, Skuša Skuš, Vèrnut
Norway.....	Makrell
Poland.....	Makrele
Portugal.....	Sardas
Spain.....	Barat, Bisol, Brat, Caballa, Sarda, Verat, Viat, Verdel
Sweden.....	Makrill
Turkey.....	Yskoumry
United States.....	Mackerel, Common Mackerel

The several species of mackerel in the genus *Pneumatophorus* are known by the following common names in the countries where they are caught commercially:

Country	Common name	Scientific name
Australia.....	Mackerel	<i>P. australasicus</i>
California.....	Pacific Mackerel ¹	<i>P. diego</i>
England.....	Spanish Mackerel	<i>P. colias</i>
Japan (inshore species).....	Hirasaba, Masaba	<i>P. japonicus</i>
Japan (offshore species).....	Marusaba, Gomasaba ²	<i>P. tapeinocephalus</i>
New Zealand.....	Southern Mackerel	<i>P. australasicus</i>
	Australian Mackerel	
	Tawatawa	
Peru.....	Caballa	<i>P. peruanus</i>
Portugal.....	Cavala	<i>P. colias</i>
United States, Atlantic.....	Bull's-eye Mackerel	<i>P. grex</i>
	Chub Mackerel	

THE MACKEREL AND SO-CALLED MACKERELS OF CALIFORNIA

Pacific Mackerel

Three species of marine fishes bearing the name mackerel—with some modifying adjective—appear in the commercial fish catch of California. The most important of these, the one on which the fishery is

¹ Pacific mackerel is the official name as designated by the California Division of Fish and Game. A list of the unauthorized common names, still used to some extent, can be found on page 14. The scientific name for the Pacific mackerel is the subject of a controversy among ichthyologists, some of whom consider it the same species as one of the Japanese forms, *P. japonicus*, or at most a subspecies, *P. japonicus diego*. However, for the purposes of this bulletin the specific distinction will be made; see Jordan and Hubbs, 1925.

² These common names are derivatives of the root word "saba" as applied in Japan to all mackerel in general.

based, is the Pacific mackerel. The other two are the Spanish mackerel and the horse mackerel.

The Pacific mackerel, *Pneumatophorus diego*, is a member of the mackerel family (Scombridae) in which are also classed the Atlantic mackerel, the tunas, bonitos, and Spanish mackerel. It is closely related to the Atlantic mackerel, *Scomber scombrus*, and the chub mackerel of the Atlantic, *Pneumatophorus grex*. It is considered by some ichthyologists to be the same species as the mackerel of Japan, *Pneumatophorus japonicus*, but is usually separated specifically or subspecifically.

The Pacific mackerel is a rather small fish, seldom exceeding eighteen or twenty inches in length and three pounds in weight.

A number of easily recognized external characteristics distinguishes the Pacific mackerel from all other fish encountered in California waters. The distinctive coloration is the easiest means of identification. The upper part of the fish is dark green with bluish metallic reflections, shading into iridescent silver on the sides and belly. The back is most often heavily marked with wavy blackish stripes that turn and twist, sometimes giving the effect of vertical bars; on other specimens the bars appear almost like horizontal stripes. Interspersed among the stripes are large and small spots. The striping and spotting are exceedingly variable. Usually there are about thirty of the wavy streaks, sometimes they are fewer and proportionately larger, often they are more numerous and very fine. Occasionally the stripes are lacking, their place being taken by numerous closely spaced spots. Rarely a mackerel is encountered that lacks all markings, being uniformly green above and silvery below.

The structure of the mackerel is ideally suited for the active life the fish leads. It is shaped like a torpedo with a powerful tail fin. (See Fig. 2.) The head is pointed, offering but little resistance to the water. The round, tapering body is covered with very fine scales and bears well-developed fins. Behind the second dorsal fin and the anal fin are series of five or six finlets, and there are two very small keels on each side of the tail at the base of the caudal or tail fin.



FIG. 2. Pacific mackerel (*Pneumatophorus diego*). Photograph by J. M. Hawthorne.

The geographical range of the Pacific mackerel extends from Vancouver Island to Lower California and possibly farther south. Although the pilchard fishermen of the west coast of Vancouver Island occasionally take quantities of mackerel in their purse seine hauls, the fish is not consistently taken north of San Francisco. It is possibly most abundant in Monterey Bay and off the coast of southern California.

The Pacific mackerel is blessed, or cursed, with a number of local or vernacular names—American mackerel, striped mackerel, zebra mackerel, green mackerel, green-back mackerel, corn-fed mackerel, tinker mackerel, and right mackerel. The official common name as adopted by the California Division of Fish and Game is Pacific mackerel.

The habits of the Pacific mackerel can be summed up in two words—gregarious and voracious. The fish sometimes run in schools of great size, as single seine hauls of fifty tons or more are on record. Many times, however, the mackerel run in small groups, feeding in kelp beds or near piers. The large schools are found from a quarter of a mile to several miles offshore. The food of the mackerel consists in large part of small fish and crustaceans, largely copepods. The appetite of the mackerel is enormous. They have been known to go on feeding after their stomachs were stretched almost to bursting. I have known of more than one mackerel taking a bait when its stomach already contained as many as eight or nine 5-inch anchovies. Buttons, spools, stones, pieces of onion and orange peels have been found in their stomachs. I once opened a mackerel that contained a lamb spare rib, one-third as long as the fish itself. At times, however, they refuse all bait, even disdaining small live fish thrown to them.

Spanish Mackerel

The Spanish mackerel, *Scomberomorus sierra* (see Fig. 3), is also a member of the mackerel family. It is classified in the same genus as the well-known Spanish mackerel of the American east coast, *Scomberomorus maculatus*, and is considered by some ichthyologists to be the same species.

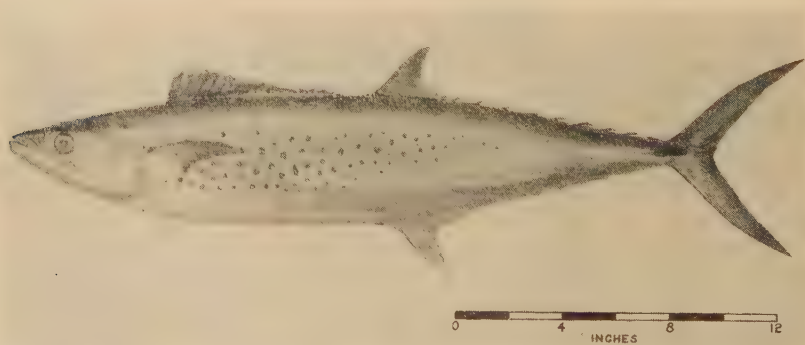


FIG. 3. Spanish mackerel (*Scomberomorus sierra*). Photograph by J. M. Hawthorne.

The Spanish mackerel, or sierra, as the Mexicans call it, is easily distinguishable by the rows of finlets following the dorsal and anal fins, the extremely slender body, and the five or six rows of either orange or blue spots along the side. It is dark steel blue above, shading into silvery on the sides and belly. It attains a length of about three feet.

This fish occurs off the coast of Mexico and Central America from the Cortez Banks south to the Galapagos Islands. Occasionally it strays north as far as San Pedro, California. During the summer of 1931 when the temperature of the water off southern California was very high, a number of Spanish mackerel was taken by San Diego and San Pedro fishermen.

All the commercial landings of this species are from Mexican waters. Deliveries of the Spanish mackerel are few and small, not because of a lack of abundance but primarily because a market for this fish has not been built up. (See Fig. 59.)

Horse Mackerel

The third of the so-called mackerels is the horse mackerel, *Trachurus symmetricus*. (See Fig. 4.) This fish is not a mackerel at all, but was given its name because of a similarity of shape and habits. It is a member of the jack family (Carangidae) in which the yellowtail, amberjack and yellowjack are classified.

The horse mackerel can be distinguished from our other fishes by the abrupt drop in the lateral line just above the ventral opening, and the row of sharp bony scutes that follow the lateral line from that point back to the tail. In color the fish is dark green, mottled with lighter shades, blending into dull silvery below. It attains a length of over eighteen inches and a weight of about three pounds.

The range of the horse mackerel on the eastern coast of the Pacific is from San Francisco south to Chile. It is not commonly taken north of Monterey, at which port and Los Angeles the largest California landings are made. Some ichthyologists claim it belongs to a world-wide species.



FIG. 4. Horse mackerel (*Trachurus symmetricus*). Photograph by J. M. Hawthorne.

The horse mackerel is often incorrectly called Spanish mackerel by fishermen and dealers in the Los Angeles region. Difficulties in catch studies arise from the use of the name Spanish mackerel, which properly belongs to a dissimilar fish, *Scomberomorus sierra*. The fine distinction of the name "Spanish mackerel" for *Trachurus* and "regular Spanish mackerel" or "spotted Spanish mackerel" for *Scomberomorus* is scarcely enough.

Because of the similarity of names, the Pacific mackerel and the horse mackerel were not separated in California catch statistics until 1926, when after several attempts a special effort was made to keep the two rather dissimilar species separate. Even now (1931) small amounts of horse mackerel are entered in the records as mackerel. As a result of the former combination of the two fishes, no report on the mackerel fishery could be complete without numerous references to the horse mackerel.

The horse mackerel is not of very great importance in the fisheries of California, principally because the market for it has not been developed. (See Fig. 16.) At Monterey, 4 per cent of the combined mackerel and horse mackerel catch is composed of horse mackerel. During 1926-1927 the San Pedro catch of horse mackerel comprised 11 per cent of the combined catch of the mackerels. This figure dropped to $1\frac{1}{2}$ per cent in 1928-1929 because of the immense amounts of Pacific mackerel taken by the canneries in those years.

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II. HISTORY OF THE CALIFORNIA MACKEREL FISHERY

PRIOR TO 1880

The fishing industry of California is not a new thing. Considered in its broadest sense commercial fishing has existed at least since the days of the earliest Spanish explorers.

The Indians, who were comparatively numerous, subsisted in great measure on fish and shellfish. The river tribes caught salmon, lamprey, trout, sturgeon and other fish. The coastal Indians gathered clams, mussels and abalones, and caught fish of all sorts with crude lines and traps. The Spanish explorers found that the Indians of the interior carried on trading operations with the coastal tribes whereby they could obtain dried fish and the ornamental shells they prized so highly.

During the periods of the Spanish missions and successive Spanish and Mexican colonization (about 1775-1847) fishing was scarcely conducted on a commercial scale. Bartering between Indian tribes continued and the Indians supplied the white settlers with food, but the Indians were being exterminated by the diseases the white men brought; and the white population increased but slowly, so the amounts of fish consumed were negligible. The Californians themselves were too proud to work at fishing and preferred hunting as a sport, so their influence on the fish life of California was of no importance.

Early in the nineteenth century (about 1820) New England whalers and fur seekers began to exploit the abundant supply of fur seals, sea otters and whales to be found off the California coast in those days. The Alaska Russians in their search for sea otters and fur seals worked down the coast as far as Fort Ross, 65 miles north of San Francisco Bay, where they established a fur station and village in 1812. The Spaniards drove the Russians out, but not before they had taken numbers of marine fur bearers. Furs and whale oil were the most important fisheries products until shortly after United States occupation and continued to be important for many years.

It was not until after the gold rush excitement (1848-1855 and later) had abated somewhat that commercial fishing for food fish attained any prominence. The hopes of finding gold brought thousands of people to the new El Dorado. Many of them stayed and sent for relatives and friends. The phenomenal growth in population that has continued to the present had started. With more people settling in towns and cities, the demand for commercially caught fish grew. Many of the Chinese and white men who had succumbed to the gold fever were skilled fishermen and they were soon exploiting the waters of San Francisco Bay and the ocean from Bodega Bay to San Diego.

While the fisheries for many other fine food fishes became more and more important, and in some cases passed their zenith, the mackerel remained on the list of neglected fishes.

The first California mackerel of which we have record were taken off Monterey in 1839 by Captain Beechey. The mackerel was redis-

covered many times subsequently and given a new scientific name nearly every time. It attracted the attention of scientists rather than fishermen, however, so that it did not become commercially important for many years after its discovery.

The *Telegraph* (Gloucester, Mass.) of July 20, 1870, as quoted by Goode (1884, p. 305), contains some interesting notes on early day mackerel fishing:

"Mackerel are reported quite abundant along the coast of California, but the people of that State have not learned to catch them, and continue to import their Mackerel from the Eastern States. Only one or two attempts have been made to avail themselves of a supply nearer home. In 1855 a few San Francisco fishermen made a trip to Santa Barbara Channel in a small schooner, and soon filled her with Mackerel, but instead of cleaning them and soaking them out they threw them into salt without dressing, and when they arrived home their fish were, of course, in bad order. A more experienced captain in 1858 put up properly a hundred barrels of No. 2 Mackerel at Santa Barbara, which he disposed of at \$16 per barrel. The San Francisco *Bulletin* claims that enough can be caught there to supply the want of their market, while salt of the best quality for curing them can be got free from the neighboring salt-water lagoons. It says that the Mackerel abound there all the year round—which is probably incorrect—but that the months for taking them in the largest quantities are June, July, and August. 'If Mackerel are caught before June and after August,' says the *Bulletin*, 'they are too poor to cure to advantage, and deserve the name of "leather-bellies." And if they are not cleaned and washed in salt water immediately after being caught, and before salting, they will spoil and become at least inferior food. But with necessary experience, skill, and judgment on the part of the fishermen and the encouragement, enterprise, and outlay on the part of all interested in trade and the development of our home industries, there are Mackerel enough on our coast of the best quality to supply all the wants of our city and State.'"

The mackerel fishery evidently did not come up to expectations, for in writing of Pacific coast fisheries in 1879, Jordan had very little to say about the mackerel. According to him (as quoted by Goode, 1884, pp. 304-305) the fish was known variously as "tinker mackerel," "mackerel," "Easter mackerel," and "little mackerel." "It reaches a length of about fourteen inches. It ranges northward to Monterey Bay, appearing in the fall in irregular and often large schools, usually disappearing in November. Some years few or none are seen. It is a good food fish, but little attention is paid to it, on account of its small size and irregular occurrence."

In the light of what we know now, the foregoing quotation is not true. The mackerel reaches a length of over twenty inches, it ranges as far north as British Columbia, it is present in California waters at all times, and it is the subject of an intensive fishery.

1880 TO 1889

During the decade after 1879 the fisheries of California underwent a considerable development. The mackerel remained relatively unimportant, but by 1888 there were records of mackerel entering the markets of the State in some numbers.

Collins' report for 1888 (published 1892) contains considerable information about the mackerel fishery of those days. The following notes have been compiled from it:

Large schools of mackerel appear off San Diego in April. They remain a few weeks and go north, returning in October or November on their way to

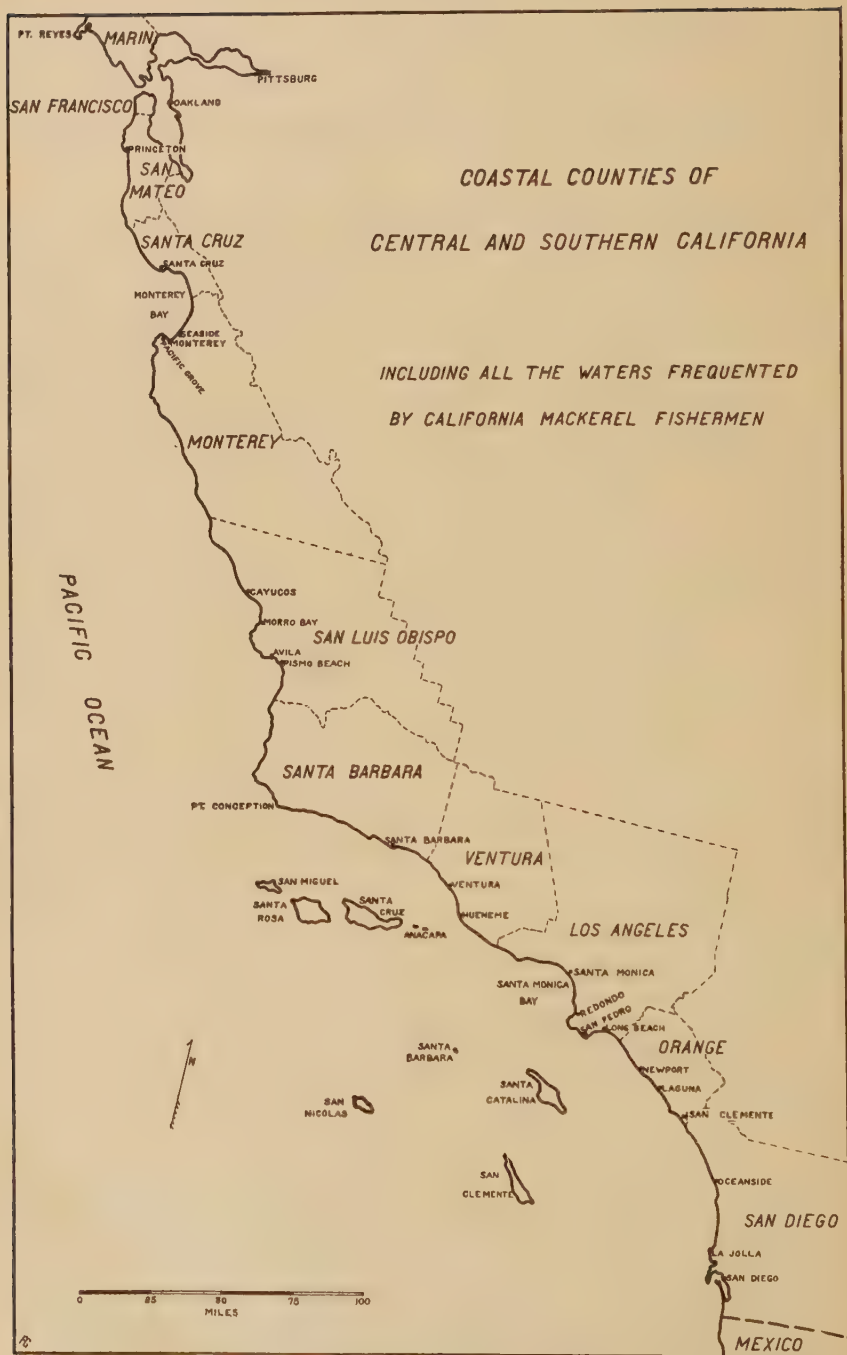


FIG. 5. Map of coastal central and southern California, showing the towns where the mackerel fishery is centered. For greater detail of the Los Angeles region, see figure 30.

Mexico where they spend the winter. They are moderately abundant in the vicinity of Santa Barbara from May to October. The fish appear in San Luis Obispo Bay in August and remain until October. Their sojourn in Monterey Bay is from July to September and occasionally as late as December. They are rare north of Santa Cruz. A few remain off the California coast all year. Even in the summer they are nowhere as abundant as the Atlantic mackerel is off New England. Their appearance and departure are erratic and little is known of their migratory habits.

They are from 1 to 3 pounds in weight, averaging $1\frac{1}{2}$ pounds each. They never get fat and do not improve with the advancing season like the Atlantic mackerel. When salted, the flesh is dark in color and is an inferior article of food, though when fresh it sells readily in the market. Little attention is paid to the mackerel, which is held in small esteem by most of the coastal inhabitants.

Barracuda and bonito boats take the mackerel off the southern California coast by trolling with a bone or cloth drail (jig) on a 60-foot line. At Port Harford (now called Port San Luis) the New England fishermen operating there have introduced jigging as practiced on the Atlantic coast. They fish about a mile offshore in 13 to 17 fathoms of water. In Monterey Bay gill nets and more particularly hand lines are used to take mackerel.

Horse mackerel, *Trachurus symmetricus*, are taken in Monterey Bay in greater numbers than the mackerel but bring a lower price. Small numbers of the Monterey Spanish mackerel, *Scomberomorus concolor*, are taken at Monterey in the fall.

Since the time of the report from which the above notes came, improved gear and methods of fishing have proved that really large numbers of mackerel are present off the coast throughout the year. The fish are in good condition most of the time, and fat ones suitable for salting or canning are abundant. The Monterey Spanish mackerel had not been taken for about forty years until two were caught during the summer of 1931, but as scombroid fishes seem to come and go at irregular intervals it may reappear in numbers at any time.

The amounts of mackerel sold in the retail markets of San Francisco, then the State's largest city, give a good idea of the small scale on which the mackerel fishery was conducted. In 1889, horse mackerel (*Trachurus symmetricus*) was the twelfth fish in retail value at San Francisco and the mackerel (*Pneumatophorus diego*) was nineteenth. The following table³ gives the amounts in pounds sold in San Francisco retail markets:

Species	1888	1889
Mackerel	25,000	30,000
Horse mackerel	100,000	125,000
Monterey Spanish mackerel	100	100

Mackerel retailed at prices ranging from 10 to 20 cents a pound, for an average price of about 10 cents in 1888 and $12\frac{1}{2}$ cents a pound in 1889. When particularly scarce it brought as much as 30 or even 50 cents a pound. The Monterey Spanish mackerel was highly prized and generally brought \$1.50 a pound retail. The horse mackerel was said to be worthless in 1879, but by 1889 the price averaged 8 cents a pound and occasionally rose to 20 cents. It must be remembered, in discussing prices, that fish on the whole commanded a much higher price then than now (1931).

In the introduction to the report from which the foregoing notes were taken, Collins gives some suggestions in regard to the California mackerel fishery that are worth quoting in full:

³ Collins, 1892.

"At present there seems to be an opportunity for the establishment of a mackerel fishery on the coast of California south of Monterey. There is a remarkable consensus of statement as to the moderate abundance of the bull's-eye mackerel along the California coast, and it would seem to be entirely feasible to make catches with comparatively small outlay for vessels and equipment. The common mackerel is now exceptionally scarce in the western Atlantic and perhaps may not be abundant for a series of years. In the meantime, the demand for salt mackerel is partially supplied by importations from foreign countries, and large quantities of fresh fish of this species are also brought from Canada at considerable expense. It is therefore important that this demand should be supplied, so far as practicable, by the products of American fisheries.

If the proper methods are adopted, it may be feasible to bring quantities of the bull's-eye mackerel from the west coast to the markets of the Central States, and even as far as the Atlantic coast. A profitable business might be inaugurated by canning mackerel in this region if the supply is sufficient to warrant the attempt and the quality of the fish is suitable for packing in this manner."

1890 TO 1908

Evidently the mackerel fishery did not develop as Collins hoped and suggested, as catch figures for 1890, 1891 and 1892 do not show much of an increase over those of 1889, and in 1895 the mackerel fishery had dwindled to less than one-third in poundage and to about one-fifth in value of that of 1889. (See Table 2.)

TABLE 2

Mackerel Catch of California, 1889-1908

Year	Pounds	Value	Year	Pounds	Value
1889	315,253	\$13,249	1899	153,666	\$6,415
1890	311,564	12,698	1900		
1891	518,883	20,863	1901		
1892	350,399	14,159	1902		
1893			1903		
1894			1904	134,922	3,666
1895	90,390	2,637	1905		
1896			1906		
1897			1907		
1898			1908	197,000	3,300

By gear, 1895

Hand lines	61,302 pounds
Gill nets	18,500 pounds
Seines	10,588 pounds
Total	90,390 pounds

By gear, 1904

Lines	47,082 pounds
Gill nets	66,630 pounds
Seines	15,000 pounds
Trammel nets	6,280 pounds
Total	134,992 pounds

By counties, 1895

Santa Cruz	35,000 pounds
Monterey	9,000 pounds
San Luis Obispo	1,000 pounds
Santa Barbara	11,000 pounds
Ventura	— pounds
Los Angeles	29,390 pounds
Orange	— pounds
San Diego	5,000 pounds
Total	90,390 pounds

By counties, 1904

Santa Cruz	39,100 pounds
Monterey	20,000 pounds
San Luis Obispo	— pounds
Santa Barbara	500 pounds
Ventura	500 pounds
Los Angeles	66,392 pounds
Orange	8,000 pounds
San Diego	500 pounds
Total	134,992 pounds

*Including 5,000 pounds salted mackerel.

†Including 14,000 pounds salted mackerel.

‡In 1904 the cannery at San Pedro took delivery of 426,300 pounds of "Spanish mackerel."

These figures are from statistics collected by the United States Bureau of Fisheries.

In 1895 most of the mackerel were taken on hand lines, with gill nets and seines furnishing the remainder. Santa Cruz and Los Angeles counties were the leading districts. The Monterey Bay region provided nearly one-half the total. San Francisco was the largest market.

In 1893 a sardine cannery at San Pedro packed the first mackerel to be canned in California. The fish that were utilized were the horse mackerel (*Trachurus symmetricus*), called Spanish mackerel at San Pedro, and the Pacific mackerel (*Pneumatophorus diego*) called horse mackerel and steelhead mackerel at San Pedro in those days. The former was considered more desirable for canning. Although hand lines were the established gear for fresh market mackerel, a purse seine was employed to catch horse mackerel and mackerel for the cannery. The net, which was 135 fathoms long, 17 fathoms deep and of 2-inch mesh, was circled from a small seine boat acting in conjunction with a gasoline-powered vessel. The hauls were both small and infrequent. The fishing was done in San Pedro Bay and around Catalina Island. The fish were packed in oil in half-pound square cans and in mustard, tomato sauce or souse in 2-pound oval cans. Small fish were canned and the larger ones salted. Neither the canned nor salted mackerel was a success, so the cannery ceased production in 1894 and concentrated on sardines.

In 1899, the next year for which data are available, the mackerel fishery showed a little improvement over 1895. Statistics for 1904 and 1908 show that the fishery continued to be a minor part of California's fishing industry. In 1904, and probably some of the other years for which data are lacking, some so-called Spanish mackerel were canned at San Pedro. Los Angeles County was the leading district in 1904, followed by Santa Cruz and Monterey counties. About half the total mackerel catch was taken by gill nets. Hand lines were an important factor and lesser amounts were taken in seines and trammel nets.

The fisheries for horse mackerel and Spanish mackerel can not be followed for these early years because of a confusion of common names that existed then. Whenever a new country is settled, the haphazard naming of new species with familiar but often unsuitable names results in a duplication of nomenclature. Some fish are called by different names at different places and the same names are bestowed upon dissimilar fishes at other points. So it was that the word "horse mackerel" was used in California to refer to the bluefin tuna, *Thunnus thynnus*, and to the albacore, *Germo alalunga*, as well as to *Trachurus symmetricus*, the fish now known as horse mackerel. The word "Spanish mackerel" was not only given to the Spanish mackerel of Mexico, *Scomberomorus sierra*, but to the Monterey Spanish mackerel, *Scomberomorus concolor*, to the horse mackerel, *Trachurus symmetricus*, and even to the bonito, *Sarda chiliensis*. Scientific names are not often used in the early statistical reports, so the confusion of common names renders a presentation of horse mackerel statistics impossible.

1909 TO 1926

Although there is very little definite information regarding the mackerel fishery between 1908 and 1916 it can be inferred that a rather

sudden development took place during that period, as catch statistics for the latter year showed a total landing of 1,114,000⁴ pounds, or over five times that of 1908. As the Monterey Bay season of 1916 was a total failure, practically all of this relatively large amount was the result of the Los Angeles County fishery.

From 1916 to 1927, the total California mackerel catch increased steadily with occasional upward fluctuations due to cannery operations. The gradual growth was due to an increasing demand for fresh mackerel that has continued to the present (1931) so that today the mackerel is one of the leading fresh market fish. A steady demand coupled with a remarkably reliable supply during every month of the

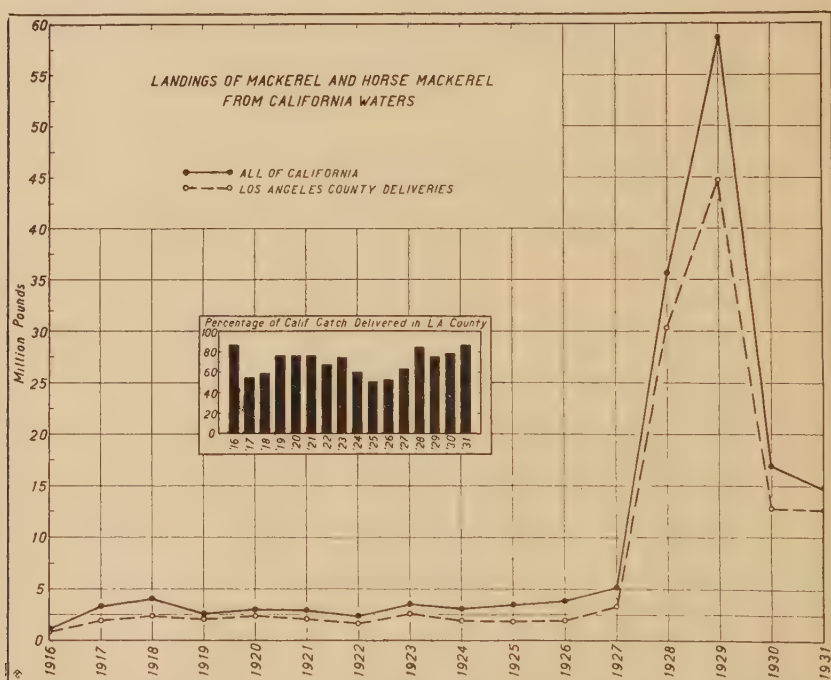


FIG. 6. Yearly landings of mackerel and horse mackerel in California. Prior to 1926, no distinction was made between the two species in catch reports; both were listed as mackerel. To make the figures for the later years comparable, mackerel and horse mackerel were combined in making this graph. Note that the bulk of the catch is landed in Los Angeles County.

year insures the mackerel a leading position in the fresh fish field. From 1923 to 1927, the mackerel was sixth in total landings of fish that are delivered almost exclusively to fresh fish markets. In 1926, the mackerel was ninth in the landed value of fresh fish, exclusive of shellfish. About 4,000,000 pounds a year are now taken by wholesale fish dealers. A rather small proportion of this amount is salted, dried or smoked, but the major portion is consumed fresh.

While the fishery for fresh mackerel pursued its even course with infrequent oversupplies or shortages, mackerel canning had its ups and

⁴ This and all following California statistics collected by California Division of Fish and Game, Bureau of Commercial Fisheries.

downs. There were plenty of canneries and enough mackerel available to make a big packing industry possible. Several elements tended to restrain mackerel canning, however. In the first place, there were usually ample supplies of other fish suitable for canning. A market had been provided for these fish, but not for mackerel. No one person or company felt justified in taking a risk with an unknown product. Moreover, trial packs that were made from time to time were not always successful from a quality point of view. Nevertheless, a few efforts have been made to pack mackerel on a large scale. The last of these was in 1928. It was successful, and mackerel canning has taken its place alongside the packing of sardines and tuna in southern California.

In 1914-1915, Nicolas J. Kuglis, then of the South Coast Company in Long Beach, put up a trial pack of seven or eight thousand cases of mackerel.⁵ The fish were caught during full moon periods by the sardine lampara fishermen.⁶ The cannery had difficulty in getting enough of the mackerel, which were comparatively expensive to catch. Production costs were high and it was difficult to get a new product established in the market, so that after one season the cannery suspended operations on mackerel. The fish were packed "salmon-style" in 1-pound tall cans very much as at present.

During the World War several canneries at San Pedro and San Diego put up a mackerel pack of typical war-time quality. In 1918 particularly, when the albacore run was below normal, the San Pedro canneries put up considerable quantities to meet the inflated demand for canned fish. At San Diego the flurry of activity was short-lived, but at San Pedro packing continued until 1920. The fish were put up in 1-pound tall and half-pound tuna cans. From 1918 to 1920, inclusive, San Pedro district canneries packed 8689 cases of 1-pound tall and 10,487 cases of half-pound tuna cans (48 to a case) and 988 cases of quarter-pound cans (96 to a case). The pack was distinctly a war-time product and as a consequence failed to become a lasting success. It has been said that the fish were not exhausted or pre-cooked long enough and therefore did not hold up under the prevalent conditions of rough handling.

In 1919 the United States Bureau of Fisheries conducted mackerel canning experiments at San Pedro in order to provide cannerymen with some knowledge regarding packing methods. Their technicians developed an excellent pack and some of the cannerymen became enthused, but as soon as the albacore began to run their interest died down so that little came of the experiment.

During 1923-1924 the Van Camp Sea Food Company put up a specialty pack of fillet mackerel. According to the West Coast Fisheries (1930, p. 38) it was a well-packed, quality product designed to sell to a high class market. Under the management of specialty salesmen it sold remarkably well. Due to reorganization in the company, the salesmen were recalled and the pack was discontinued. About 9000 cases of 1-pound oval cans were packed. Although over half that amount was reported as canned in 1924, it was all packed late in 1923. Delayed cannery reports account for the 1924 figures in Table 3.

⁵ West Coast Fisheries, 1931, p. 95.

⁶ Sardine fishing is done only at night during the dark of the moon when the luminescence betrays the presence of the schools to the fishermen.

Prior to 1923, the reduction plants that are operated in conjunction with San Pedro canneries took delivery of quantities of mackerel. The fish were made into fertilizer. The approximate amounts so used were:⁷

160,000 pounds in 1919
350,000 pounds in 1920
350,000 pounds in 1921
130,000 pounds in 1922

At present there is a law prohibiting the reduction of fish other than sardines except for the offal left over from canning operations. The canneries may reduce a certain percentage of the sardines they receive.

1927 TO 1931

To all outward appearances the mackerel was destined to remain essentially a market fish. All efforts to can it had met with ultimate failure. It came as a great surprise to the fishing industry when in October, 1927, Toyo Fisheries of Wilmington suddenly began packing mackerel in earnest. The cannery continued large scale operations and seemed to have no difficulty in marketing the new product.

Although Toyo's action appeared to be unpremeditated, coming as it did out of a clear sky, it was the result of years of experimenting with canning methods and of studying potential markets. In 1925, George K. Ogawa, president of the cannery, began to experiment. Late in 1927, everything was ready for large scale production. His success was in great measure due to the fact that he took his time and worked out all details before attempting to market his product, whereas other canners had often tried to sell their experimental packs and thereby created a bad impression with what was all too often an inferior article.

Ogawa waited until he was sure before he started selling his mackerel. The method he evolved remains the most popular to the present, although slight departures are made at every cannery. Briefly the method is as follows: The fish are beheaded, cleaned and cut upon arrival at the cannery; the pieces are given a brine bath; the brined pieces are put raw in No. 1 tall cans; salt is added; the cans are given a steam cook and then sealed; and the sealed cans are retorted at a high temperature.

For a market, Ogawa went direct to the Philippines, one of the largest consumers of sardines and pink salmon. As the inhabitants of those islands were accustomed to salmon and had never heard of canned mackerel, a ruse was resorted to in order to get the mackerel started. The Toyo people and most of the other canneries that soon commenced mackerel canning dressed their cans in labels that resembled salmon labels very closely. Nearly all bore a picture of a salmon-like fish and the words "salmo brand," "salmon style pack," or something of the sort, were placed in a prominent position. Naturally the buyers thought they were getting a new kind of salmon at a real low price, so sales mounted rapidly.

⁷ Fry, 1930, p. 30.

TABLE 3
Number of Cases^a of Mackerel Canned in California

	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
San Pedro.....														
1 pound tall.....	3,450	1,995	3,244	255	205					10,725	357,136	477,570	122,858	100,912
1/2 pound.....	4,068	6,344	75								4,717	39,392		
1/4 pound.....		988												
1/2 pound oval.....						3								
1 oval filets.....						3,783	5,229						15	
San Diego.....														
1 pound tall.....		66												
1/2 pound.....		17	6						4		25,110	86,246	4,250	305
1/4 pound.....			13							236	208	7,574		
1/2 pound oval.....									9		270			
Monterey.....														
1 pound tall.....			67			271					1,030	1,476	117	
1/2 pound oval.....									537					
State totals.....														
1 pound tall.....	3,450	2,061	3,311	255	205	271			4	10,725	383,276	565,292	127,225	101,217
1/2 pound.....	4,068	6,361	81							236	4,925	46,966		
1/4 pound.....		988	13								270			
1/2 pound oval.....						3			546					
1 oval filets.....						3,783	5,229						15	

^a48 cans to case, except that 1/4-pound cans are 96 cans to case.

To be added to 1931—36,700 cases of 1-pound tall animal food made from whole mackerel, and 6,325 cases of 7-pound cans, 6 to a case, of same.

Statistics collected by Bureau of Commercial Fisheries, California Division of Fish and Game.



FIG. 7. Mackerel boats waiting to unload at a Terminal Island cannery, September, 1928. This was before mackerel gear became standardized, and three early forms can be seen in the picture—a hook and line boat with its bait net is in left foreground, a purse seiner is in left background, and a lampara boat in right foreground. Photograph by author.

For the next development in the new industry we must turn to Seattle. The salmon packers of the Northwest became alarmed when they saw their market invaded with what was brazenly presented as a salmon substitute. They induced the United States Government to persuade the mackerel packers to offer their product on its own merits and cut out all references to salmon on the labels. No better thing could have happened to the mackerel industry, for although sales dropped sharply at first, the mackerel under its own name has now taken its place alongside the salmon. The buying public knows the mackerel and its inexpensive quality.

Toyo had scarcely gotten production into full swing when the other Los Angeles Harbor canneries fell into line one by one. At first some of them encountered difficulties in producing a good pack but before the end of 1928 several plants were going at top speed. The Los Angeles County mackerel catch rose from 3,500,000 pounds in 1927 to 30,000,000 in 1928. During 1927 a total of about 10,000 cases, then the record, was packed. Production in 1928 reached a total of approximately 360,000 cases.

It was soon seen that the tiny hook and line boats, while capable of supplying the fresh fish demand, could not begin to keep the canneries busy. The small sardine net boats at once gained control of the cannery mackerel fishery and have maintained their leadership.

In 1929, production at Los Angeles Harbor and Long Beach was even greater than in 1928. Most of the sardine and tuna canneries operated steadily on mackerel. During that year, a total of 45,000,000 pounds was taken by the canneries of Los Angeles County. The equivalent of about 500,000 cases (48 No. 1 cans) was packed in this district.

The San Diego sardine and tuna canneries had been watching the San Pedro experiment closely. In fact, two of them had been carrying

on some independent research during 1927. In February, 1928, one of the canneries started large scale production to be followed in November by another. A total of 25,000 cases was packed that year. Several more canneries came into the fold during 1929 and production reached 90,000 cases.

Some of the Monterey sardine canneries had packed insignificant amounts of mackerel from time to time, but in 1928 they made elaborate preparations to operate on a large scale. However, their fishermen were not able to catch sufficient mackerel so that in 1928 but 1000 cases were packed. About 1500 cases were filled in 1929.

The Philippine Islands and southeastern Asia continued as important outlets for the tremendously increased production but a domestic market was gradually built up during the latter part of 1928. The eastern and middle western States early became good customers as the people had already acquired a taste for mackerel from eating fresh and salted Atlantic mackerel. The southern States, however, became the best market of all. The colored people particularly greeted the new inexpensive food product with enthusiasm.

Compared with the two preceding years, 1930 showed a decline in the output of canned mackerel. The Los Angeles district canneries packed but 122,000 cases. San Diego production dropped to 4250 cases, most of which were packed in the first couple of months of the year. A number of canneries at both places shut down completely as far as mackerel was concerned and others operated on a small scale or at irregular times.

There are always some people who find a sort of pleasure in making pessimistic predictions about a new venture. The sardine and tuna industries of California had to contend with this type of person when they were being founded. The great west coast salmon industry is what it is today in spite of the discouragements that the pioneers met at the hands of ultra-conservative business men. The mackerel industry was far from being an exception. Calamity howlers, looking back at past failures, were loud in their condemnation of the new business. The year 1930 was probably gratifying to them, and at first glance it did look as though the new industry were doomed to an early death. However, closer analysis shows that nothing



FIG. 8. Early method of unloading a cannery mackerel boat with hand scoop nets. Photo by author, Terminal Island, September, 1928.

more or less than a slump could be expected. In the first place it could hardly be hoped that a normal market could absorb the enormously inflated pack of 1928-1929. Once the canners committed themselves to mackerel canning they cast aside all caution until their warehouses began to overflow. A normal market might have held up, but unfortunately for the mackerel business, markets were below normal. The phrase "world-wide business depression" is called into use all too often in explaining things that have gone wrong. In the case of the mackerel, however, its use is justified. When the mackerel first appeared as an inexpensive canned food it met with a ready sale among those who could not afford the higher priced salmon. But as the depression continued, potential customers failed to buy canned fish of any kind in quantities. The mackerel, being a new product, showed the effects of the depression the most, but the markets for salmon and sardines also suffered greatly. Sardines became a serious competitor of canned mackerel during the 1929-1930 season when 1-pound tall cans became a popular package for the sardine. It was possible to sell this similar appearing product cheaper than mackerel which in turn could be produced somewhat cheaper than pink salmon. A three-cornered competition for a reduced market had developed.

The fact that production held up during 1931 speaks well for the future of the canned mackerel industry. In that year, old markets were reentered and new ones were established. In spite of price cuts several canners were able to operate more steadily than in 1930. A development of importance in 1931 was the introduction on a commercial scale of canned animal food made from mackerel. One cannery originated and perfected a method for manufacturing this product and has met with success in selling it.

SUMMARY

Several facts stand out in a summary of the history of the California mackerel fishery. Before 1880 there was no commercial mackerel fishing of any importance. During the eighties and nineties there was some mackerel fishing, but the mackerel was still of minor importance. During the early days of the fishery, the Monterey Bay and San Pedro regions became the most important mackerel districts, positions they have maintained until the present. By 1916 the mackerel had attained a fairly important position among the fishes supplying the wholesale markets. The fresh fish catch has increased since then so that now about 4,000,000 pounds of mackerel are delivered annually to California fresh fish dealers. Mackerel has been canned on an experimental scale since 1904, but not until 1927 did canned mackerel become commercially important. During 1928 and 1929, canneries at San Pedro and San Diego packed a total of 975,000 cases of mackerel. They glutted the market, and production was curtailed during 1930 and 1931.

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III. THE CENTRAL CALIFORNIA MACKEREL FISHERY

The California mackerel fishery centers at four ports: Monterey in central California, and Los Angeles Harbor, Newport and San Diego in southern California. Mackerel fishing at other places is of a desultory nature.

SAN FRANCISCO

San Francisco is the northernmost California port at which mackerel are landed. Small amounts are caught and delivered there during the

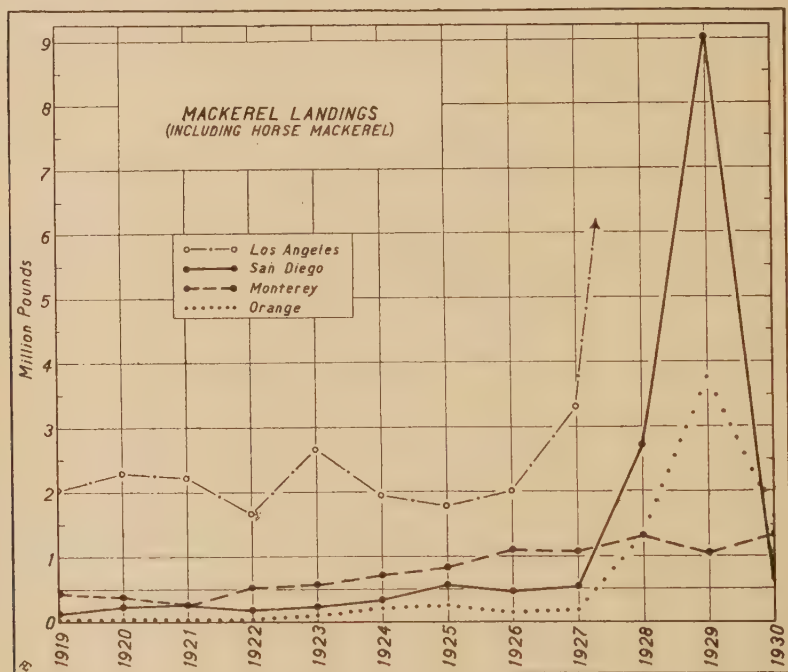


FIG. 9. California mackerel landings (including horse mackerel) by districts, 1919 to 1930. For Los Angeles catch, 1928 to 1930, see Figure 6.

winter months by the sardine boats that fish for the cannery at Pittsburg. The first time that mackerel entered San Francisco catch statistics was when the Pittsburg cannery started operating during the 1925-1926 season.

Mackerel often school with sardines and are therefore liable to be caught in sardine nets. Wherever sardine fishing is carried on in California, more or less mackerel are sure to be mixed in with the catches. So it is that the San Francisco sardine boats sometimes have a few mackerel in their catches, although seldom as many as the Monterey and San Pedro sardine fishermen catch. At San Francisco, as elsewhere, most of the mackerel thus caught find their way into the reduction plant with the sardine offal. The fishermen and cannery

workers often take small numbers home to salt or eat fresh. In neither case are the mackerel sorted out and weighed separately so there is no record of the amounts present in the catch. When the San Francisco fishermen catch a fairly high percentage of large mackerel, however, they pick the best ones out of the load and sell them to the wholesale markets on Fishermen's Wharf. Between 10,000 and 30,000 pounds are taken by the markets every year.

The San Francisco sardine boats are manned by Italians who fish with ring nets.⁸ Until the end of the 1929-1930 season, nets known as lamparas were the standard form of gear.⁹ The fishing is done at night off the Marin County shore south of Point Reyes, and near the Farallone Islands. The loads, which are carried on the deck, are transferred to tender boats at Sausalito, across the bay from San Francisco. If there are enough mackerel to make it worth while, the fishermen sort them out and keep them on their boat. The tenders carry the sardines to the cannery, which is at the head of the bay. The boats proceed to Fishermen's Wharf in San Francisco, where they tie up. Those that have some mackerel aboard try to sell them, sometimes with success, to the nearby markets.

MONTEREY BAY

Extent of the Fishery

The mackerel fishermen of Monterey Bay catch about 1,200,000 pounds of mackerel annually. Monterey is the second mackerel port of the State. (See Fig. 17.) The landings fluctuate very little from year to year in supplying a rather steady market but they show a gradual increase in keeping with the growth in population of central California. (See Fig. 9.)



FIG. 10. San Francisco sardine boat with lampara net. This is the type of boat, more recently equipped with a ring net, that catches practically all the mackerel landed at San Francisco. Photograph by author, April, 1930.

⁸ For a description of the construction and use of the ring net, see pp. 62-72.

⁹ For a description of the construction and use of the lampara, see pp. 98-99.

Practically all the mackerel caught by commercial fishermen in Monterey Bay are delivered to the fresh fish markets on the Municipal Wharf in the town of Monterey, to be utilized fresh. The mackerel is second only to the rockfish in importance as a market fish at Monterey. (See Fig. 11.) Some mackerel are landed at Santa Cruz across the bay, but there is no real mackerel fishery at that town. The Santa Cruz deliveries have varied from practically nothing in most years to as much as 62,000 pounds as in 1926.

Periodical attempts have been made to can mackerel at the Monterey sardine canneries, but the boats do not seem to be able to make catches much in excess of the fresh fish demand, so that mackerel can-

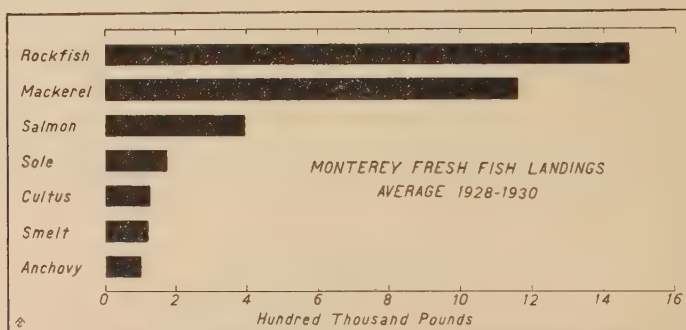


FIG. 11. Average yearly landings of the six leading fresh fish market species at the town of Monterey for the period 1928 to 1930, inclusive. "Rockfish" includes several species of the genus *Sebastes*; "mackerel" is *Pneumatophorus diego*; "salmon" includes *Oncorhynchus tshawytscha* and *O. kisutch*; "sole" includes several flatfishes of the family Pleuronectidae; "cultus" is *Ophiodon elongatus*; "smelt" includes several species of the families Osmeridae and Atherinidae; "anchovy" is *Engraulis mordax mordax*.

ning is of no great importance. (See Table 3.) Both mackerel and horse mackerel are salted and dried on a small scale at Monterey.

Price Paid to Fishermen

The usual price paid by Monterey dealers for mackerel is three cents per pound, although very small fish bring less, sometimes as little as one cent per pound. When loads are large and there is an oversupply, the price is lowered, and on the other hand when mackerel are scarce, as much as four cents is paid for them. The same prices prevail at Santa Cruz, although the dealers there cut the price at the slightest indication of an oversupply because there is little chance of selling much mackerel in that town.

Fishing Seasons

The Monterey mackerel fishery is carried on throughout the year, but the summer and fall have proved to be the best seasons. (See Fig. 12.) Except for an occasional winter storm, the bay is usually calm enough to permit fishing regardless of the season. The midwinter period is slack, probably because the fish are down deep and are hard to catch. During the late winter the fishing picks up a bit, but it falls off

from March to May. During this time the mackerel are said to bite poorly, possibly because of an abundance of food. With the coming of summer the fishermen have their greatest success.

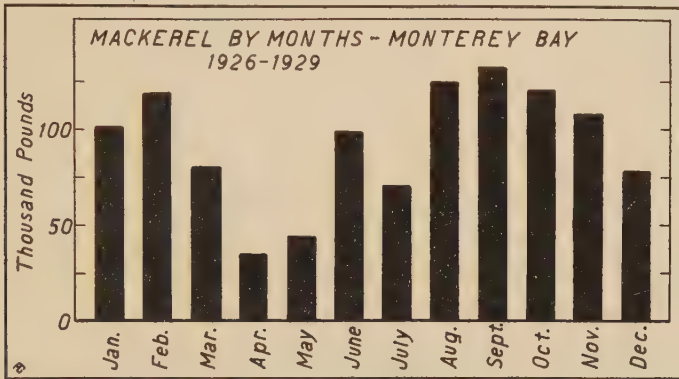


FIG. 12. Average monthly catch of mackerel (exclusive of horse mackerel) landed at Monterey and Santa Cruz, for the period 1926 to 1929, inclusive.

Fishing Methods

The Monterey mackerel fishery supports a fleet of about 35 boats that fish for little else besides mackerel. These boats are gasoline-burning launches, 23 to 35 feet long, each carrying a crew of one or two men, usually Italians. Most of the launches are the "Monterey type boat" with clipper bow, flaring sides and arched deck. This type of boat has a short mast and a small engine house amidships and the steering tiller astern. There is no cargo space below deck. Figure 13 shows a typical Monterey mackerel boat. Some of the mackerel boats have a wedge-shaped bow, straight sides and a level deck but are otherwise similar to the foregoing type. Not so many years ago the mackerel boats carried lateen sails and relied on the wind for motive power. Even though gasoline engines have been installed in all of them, triangular spreads of canvas can still be seen on the bay when the wind is favorable.

The boats usually fish inside the bay within a mile or so of shore. The schools of mackerel are said to move about in the bay, and the boats follow them, fishing from Pacific Grove to Seaside and back. The boats leave port before daybreak and usually return between nine o'clock and noon. The closely massed mackerel fleet almost within hailing distance of shore can be seen almost daily near Monterey—a picturesque sight even with the masts shorn of the triangular lateen sails of an earlier day.

The form of gear in general use is very simple. It consists of a stout cord, 4 to 7 fathoms long, at the end of which there are one or more 5/0 Mustad hooks and a lead sinker. Several lines are carried on each boat.

When the fishing grounds are reached the boat is anchored. The fishermen immediately start to chum the mackerel, that is, they attract them to the boat and get them excited by throwing quantities of finely ground sardines or other fish into the water. The hooks are baited



FIG. 13. A typical Monterey mackerel boat, 31 feet long over all.
Photograph by author, December, 1930.

with pieces of fresh sardines preferably, and the lines are cast into the rapidly congregating school of mackerel. Sometimes the fish gather at the surface, but when the water is clear it is necessary to lower the hooks to as much as seven fathoms. When fresh sardines are not obtainable for bait, fresh mackerel or squid, or salted sardines, anchovies or mackerel can be used. The fishermen hold the lines in their hands and pull the mackerel on board as fast as they bite. They throw the fish onto the after-deck or into boxes as they catch them. The average load is small, seldom exceeding 150 or 200 pounds.

For unloading, a boat ties up to the wharf on which the purchasing market is located. Men on the wharf lower a hoop net on a cable and the fishermen throw the mackerel into the net by hand or shovel them into it with small dip nets. When the net is full it is hauled to the deck of the wharf and the contents are dumped into a two-wheeled iron cart to be taken into the cleaning shed. One netful usually suffices to unload the boat.

In addition to the landings of the regular mackerel fleet, numerous small fares of mackerel are brought in by rockfish boats. These boats are similar to the mackerel boats but usually carry crews of two or three men. More than a dozen rockfish boats bring in fares of mackerel more or less regularly. At times, especially in the winter, when the mackerel are in deep water beyond the reach of the short handlines, the rockfish set lines are most effective. These lines carry about 300 size 5/0 hooks, each on a 2-foot snood fastened to the main line at 3-foot intervals. The lines are kept coiled in circular flat baskets when not in use. The hooks are baited with pieces of salt or fresh fish, preferably sardines. Heavy weights keep the line at the desired depth at or near the bottom in 40 to 75 fathoms or more of water. The rockfish are caught on the bottom, whereas the mackerel are said to take the bait

while the lines are being set or hauled in as the mackerel are not thought to live at any great depth. If the fishermen are especially desirous of catching mackerel, they use extra lines set about 9 fathoms off the bottom in addition to their regular rockfish lines. The set lines are left in the water no longer than 30 minutes, because after that length of time sharks and hagfish will have found and eaten a considerable portion of the hooked fish. When the mackerel are running at the surface some of the rockfish fishermen carry the ordinary hand lines to use while the set lines are in the water. A few mackerel fishermen regularly use long lines set near the surface instead of the usual hand lines.

When the sardine season is closed (February 16-July 31) and the canneries are not operating, many sardine fishermen with a lot of time and no money go mackerel fishing in skiffs. They fish with hand lines in the same manner as the launch fishermen. Although their catches



FIG. 14. The Monterey mackerel fleet fishing off the beach at Seaside. Photograph by D. H. Fry, Jr., April, 1930.

are small the cost of operation is negligible so that some profit is possible.

Some of the mackerel taken accidentally by the ring net and purse seine sardine boats are sorted out from the sardines before delivery to the canneries to be sold to the fresh fish markets, although there are seldom enough to be worth saving. Occasionally when the percentage of mackerel delivered to the canneries with the sardines is fairly high, the cannerymen pick out the best ones and pack a few cases. These mackerel have been weighed in and recorded with the sardines, which accounts for the fact that in some years there is a mackerel pack at Monterey without corresponding cannery mackerel receipts being recorded.

In past years it was the practice of some of the sardine boats to fish for mackerel occasionally with their nets during the off-season for sardines. They made large catches which flooded the market, resulting in temporary price drops that worked hardships on the regular mackerel fishermen. Considerable hard feeling was caused by these



FIG. 15. Unloading a mixed fare of mackerel and rockfish at Monterey. The men are throwing the fish into the hoop net, which is raised to the wharf when full. Photograph by author, December, 1930.

periodical gluts. At present, the net boats almost never fish for mackerel exclusively and sell what few mackerel they catch incidentally only when there is a shortage of that fish in the markets.

Most of the mackerel landed at Santa Cruz are taken in the summertime by the rockfish set lines. Occasionally an effort is made to get mackerel with special set lines, but the Santa Cruz mackerel fishery is at best a desultory one.

Horse Mackerel

The Monterey catch of horse mackerel is rather small compared with that of the Pacific mackerel. (See Fig. 16.) During the period from 1926 to 1929, inclusive, no more than 4 per cent of the combined catch of the mackerels in Monterey Bay was composed of horse mackerel. Nevertheless, Monterey is the second most important point of delivery for horse mackerel in California. The price paid for this species is somewhat higher than the price of Pacific mackerel, so the horse mackerel is not relatively so unimportant as would appear at first glance. Most of the horse mackerel is used fresh but some is salted and dried.

No horse mackerel are recorded as landed at Santa Cruz.

The mackerel boats catch horse mackerel in the same manner as Pacific mackerel. The net boats fishing for the sardine canneries sometimes catch horse mackerel accidentally. The fishermen often sort them out and sell them to the wholesale markets.

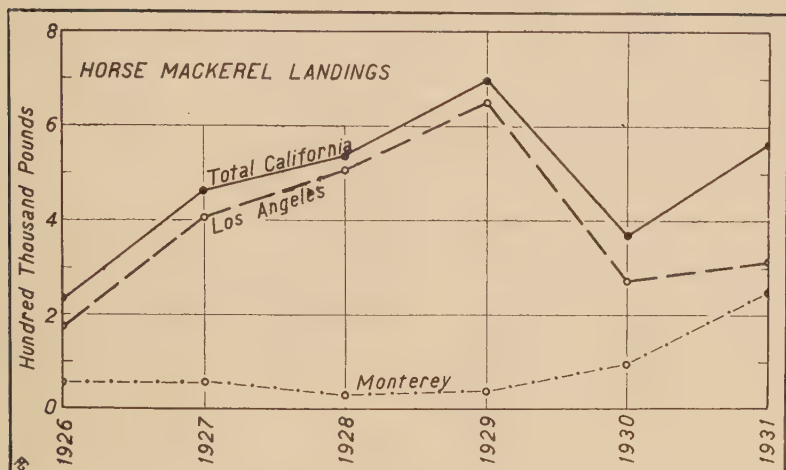


FIG. 16. Yearly landings of horse mackerel at California ports.

SAN LUIS OBISPO, SANTA BARBARA AND VENTURA COUNTIES

Between Monterey and Santa Monica bays, there is very little commercial fishing for mackerel. The dangerous rocky shores of southern Monterey County and northern San Luis Obispo County support no fishing ports, and along the less rugged coast to the southward there are but four fishing towns, none of which is of importance as far as mackerel are concerned. At the towns of Morro Bay and Avila in San Luis Obispo County small amounts of mackerel are landed but there is no regular mackerel fishery. Practically no mackerel are landed at Santa Barbara, the only commercial fishing town in the county bearing that name. The sardine cannery at Hueneme, the one fishing port in Ventura County, takes small amounts of mackerel for canning.

There is quite a fishery for sea-bass, rockfish and smelt at Morro Bay and Avila. The market at Morro Bay uses several pounds of mackerel a day and occasionally salts small quantities to order. The fish are caught incidentally on the long lines put out for rockfish and flatfish in the deep water offshore. As the lines are set in water deeper than the usual range of the mackerel, the fishermen are probably justified in their claim that the mackerel take the hooks while they are being lowered or hauled in. When special orders for fresh or salted mackerel must be filled, the fishermen employ short hand lines and fish over the side of the boat, using pieces of fish for bait. The boats fishing for rockfish out of Avila occasionally catch mackerel on their long set lines.

The fisheries of Morro and Avila supply the fresh fish markets of San Luis Obispo, Pismo Beach and other towns in San Luis Obispo County. The markets generally find it easier and more reliable to send to San Pedro for the mackerel they need rather than to have their local fishermen try to catch them in waters where they do not seem to be very numerous.

Most of the fishing at Santa Barbara is confined to dragging or trawling, gill netting and lobstering. There is no regular hook and

line fishery at that port but the few skiff fishermen, catching rock bass and rockfish, sometimes take a few mackerel which they usually have difficulty in selling. Mackerel are said to be abundant off Santa Barbara and to the southward, but no effort is made to catch them because of the lack of a market for them.

The sardine cannery at Hueneme has packed a little mackerel from time to time. During the 1929-1930 sardine season a few cases of mackerel were put up. The mackerel were mixed in with the sardines caught by the purse seine and ring net sardine boats. In the spring of 1931 the cannery sent out a few San Pedro ring net boats to fish for mackerel and canned the resulting catches. The mackerel were caught in the channel between the mainland and Anacapa Island in the same manner as described for San Pedro fishing in the following section pp. 65-72).

SUMMARY

In summarizing the foregoing discussion, these facts present themselves. North of Los Angeles County there are but six ports at which appreciable amounts of mackerel are landed by commercial fishermen. These ports, from north to south, are: San Francisco, Santa Cruz, Monterey, Morro Bay, Avila and Hueneme. The mackerel fishery of Monterey is the only one which is of any real importance. The fishing at that town is carried on throughout the year by small hook and line boats. Most of the mackerel caught north of Los Angeles County are used fresh, but small amounts are canned at Monterey and Hueneme and a little is salted and dried at Monterey.

IV. THE MACKEREL FISHERY OF LOS ANGELES AND ORANGE COUNTIES

LOS ANGELES COUNTY

The Leading Position of Los Angeles County

Los Angeles County is by far the most important mackerel fishing district of the State. About 80 per cent of the total California mackerel catch is delivered to Los Angeles Harbor and Long Beach canneries and wholesale markets. (See Figs. 6, 17.) Since 1916, when the first records were kept, Los Angeles has led all other parts of the State combined. At present (1931) practically all of the *cannery* mackerel catch and about half of the *fresh* mackerel catch for California are landed in Los Angeles County.

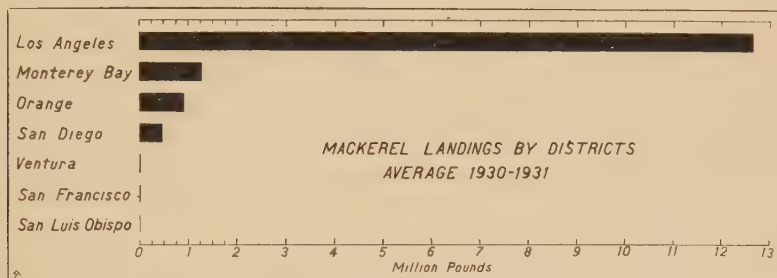


FIG. 17. Mackerel landings (exclusive of horse mackerel) by districts—average for 1930 and 1931.

The catch at Monterey, the second most important mackerel port, is but a fraction of the Los Angeles landings (one-tenth for 1930-1931). There are more boats engaged in the mackerel fishery at Monterey than at Los Angeles but the southern boats make much larger catches. (See Fig. 17A and Table 4.) The canneries at Los Angeles Harbor require considerable amounts of fish in order to operate at a profit so they send out larger boats to catch mackerel in quantities. On the other hand, the small catches of the one-man boats at Monterey are sufficient to supply the fresh fish demands at that point.

There are several reasons for this leadership. In the first place, mackerel seem to be more consistently abundant off the coast of the neighboring mainland and islands than anywhere else. The greater availability of the fish to the fishermen is the most important factor contributing to

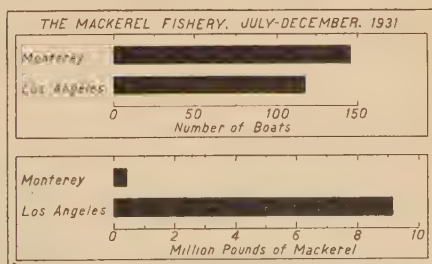


FIG. 17A. Comparison of the mackerel fishery at Monterey and Los Angeles. Notice that the 146 boats at Monterey caught less than 5 per cent as much as the 118 boats in Los Angeles County during the last six months of 1931.

the leadership of Los Angeles. Without fish there can be no fishery, no matter what the demand may be. In the second place, the large concentrated population of Los Angeles County constitutes a greater market for fish of every sort than any other part of the State. For another thing, the fish canneries centered at Los Angeles Harbor have the necessary equipment, workers, and expert fishing crews for handling mackerel on a large scale. Facilities for shipping both canned and fresh fish are excellent; railroads, highways and steamship lines radiate in all directions from Los Angeles and Long Beach harbors.

TABLE 4

Comparison of the Mackerel Fishery at Monterey and Los Angeles, by Boats and Pounds Landed, July to December, 1931

County	Pounds of mackerel	Total number of boats	Number of regular boats	Number of deliveries	Average pounds per boat	Average pounds per delivery
Monterey.....	435,000	146	41	3,370	3,000	130
Los Angeles.....	9,185,000	118	35	2,460	78,000	3,730

The mackerel fishery of Los Angeles County falls into four divisions: the major fresh fish and canned fish industries and the less important businesses of salting and smoking. The first two are conducted independently with scarcely any overlapping. For that reason they will be discussed separately in the following pages. Salting and smoking are carried on for the most part as side lines by both markets and canneries, but for the sake of convenience will be described in a third section.

Fresh Mackerel

Extent of Market Fishery

The mackerel fishery as far as the fresh fish markets are concerned is a *demand* fishery rather than a *supply* fishery. In other words, the fishermen can nearly always catch more mackerel than the market can absorb. The mackerel has not been exploited to the limit like some of our other fishes.

The mackerel, being a cheap fish, enjoys a steady demand from the class of trade that can not afford the higher priced fish. In addition it holds an important position as a substitute for expensive fish when they are scarce or out of season. It is present in southern California waters throughout the year so that it can help bridge the gaps between the seasons of the periodically scarce fish, such as the white sea-bass, barracuda and yellowtail.

Year after year the mackerel catch remains almost constant, increasing slowly as the population of southern California grows. (See Fig. 28.) Neither depressions nor booms have caused the catch to fluctuate like those of the higher priced fish. People can always afford the inexpensive mackerel during hard times and can still enjoy its wholesome flavor when other fish are within their means.

The mackerel is one of the most important of the market fish taken in California waters and landed in Los Angeles County. In amounts landed the barracuda alone exceeds it. (See Fig. 18.) The various

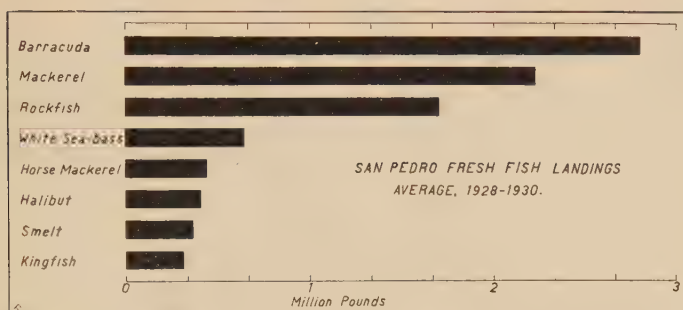


FIG. 18. Average yearly landings of the eight leading fresh fish market species caught in California waters and landed in Los Angeles County during the period 1928 to 1930, inclusive. Deliveries to canneries not included. "Barracuda" is *Sphyraena argentea*; "mackerel" is *Pneumatophorus diego*; "rockfish" includes several species of the genus *Sebastes*; "white sea-bass" is *Cynoscion nobilis*; "horse mackerel" is *Trachurus symmetricus*; "halibut" is *Paralichthys californicus*; "smelt" includes several species of the family Atherinidae; "kingfish" includes *Genyonemus lineatus* and *Seriplus politus*.

species of rockfish combined total nearly as high as the mackerel in poundage and exceed it somewhat in value because of the higher price they command. Mackerel and rockfish are the all-year consistent market fish.

Location of Markets

Most of the fresh fish markets of Los Angeles County are centered on the municipal fish wharf on the main channel of Los Angeles Harbor at San Pedro. It is here that practically all the fresh fish landed in the county are handled. This group of markets takes delivery of about half of the entire California catch of fresh mackerel. From the municipal wharf a fleet of fast trucks operates, carrying the fish to Los Angeles and the nearby suburbs. A number of retail fish peddlers' trucks also get their stock at the San Pedro wharf.

There are other dealers at Long Beach, Avalon and the Santa Monica Bay cities but their share of the fish business is relatively small.

At Newport Beach in Orange County there are several wholesale fish markets that furnish fish to the same territory that the San Pedro markets supply. For a description of the Newport mackerel fishery, see pages 91-93.

Price Paid to Fishermen

The price paid to the fishermen has remained fairly constant for several years. For small deliveries of first class, large fish, a uniform price of three cents per pound prevailed until 1930. In keeping with the general reduction in commodity prices, the figure dropped to two cents per pound during the latter part of that year. Large deliveries on any one day always tend to lower prices, so the price occasionally falls to one cent or even nothing. A lower price is often paid for small fish. When mackerel are abundant the markets refuse to accept any small fish at all, but when fish are relatively scarce they pay full price for any size they can get.

Seasons

There is very little indication of a season for mackerel. The fish are available to the hook and line boats throughout the year and the demand is fairly constant. The boats that fish for mackerel are seldom diverted to other fisheries but concentrate on mackerel the year around.

The market is best during the winter and spring when other fish are relatively scarce, so the deliveries during those seasons are a little heavier than those of the summer. (See Fig. 19.) The smallest landings are made in August and September, the months when heavy catches of barracuda drive the price of that fish down to almost the level of the mackerel.

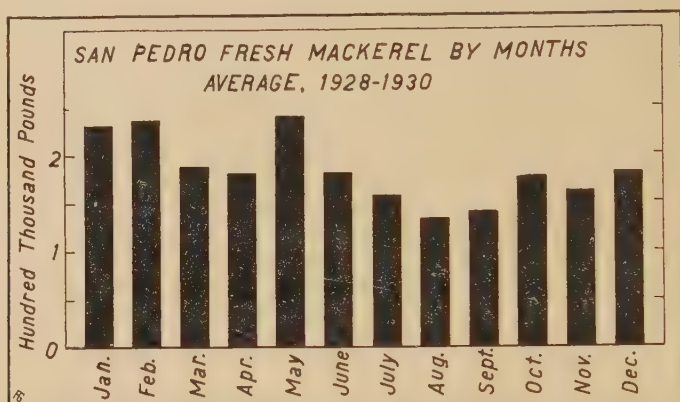


FIG. 19. Average monthly deliveries of mackerel (exclusive of horse mackerel) to San Pedro fresh fish markets for the period 1928 to 1930, inclusive.

Location of Fishing Grounds

The mackerel fishing grounds are close to San Pedro. Most of the boats fish between Point Vincente and Point Firmin within a mile or two of shore. (See Fig. 30.) When fish are scarce the boats may go as far as Catalina Island or Newport Beach.

Boats Engaged in Market Mackerel Fishery

During the last six months of 1931 a fleet of 20 boats made regular mackerel deliveries to the San Pedro markets. In addition, about 80 other boats engaged regularly in other fisheries made occasional landings of mackerel. The pleasure fishing boats operating out of Redondo Beach, Long Beach and other towns often sell small quantities of mackerel to the dealers on the piers. The many small deliveries made by these boats add several tons a year to the Los Angeles mackerel catch.¹⁰

The regular boats are practically all small set line craft operated by Japanese and in a few cases by Italians. All sorts of boats make up the mackerel fleet, but nearly all of those that fish consistently are patterned after the so-called Monterey type jig boat.

The lengths of the jig boats used at San Pedro vary from 26 to 36 feet. (See Fig. 21.) The boats are 7 to 10 feet in beam. This type

¹⁰ For fishing methods of pleasure boats, see section VIII, pp. 131-133.



FIG. 20. A typical San Pedro mackerel jig boat, 33 feet long.
Photograph by author, January, 1931.

of boat has a flaring bow and pointed stern. There is a small cabin amidships and a low mast immediately forward of the cabin. A typical San Pedro jig boat is shown in Figure 20. These boats are powered with 1-cylinder gasoline engines of 6 to 12 horsepower or 2-cylinder gasoline engines rated at 10 to 16 horsepower. The maximum speed of the average jig boat is not over 5 or 6 miles per hour. This type of boat usually has no hold; the catch must be carried on deck. Some of the larger jig boats have holds where fish and ice can be carried. The crew consists of one man, rarely two.

The jig boat tosses about on the waves like an animated cork but is as seaworthy as any small boat can be. The flaring bow prevents the boat from nosing under anything but the choppiest of waves, and what water does come aboard runs off the high-crowned deck as off the proverbial "duck's back."

Gear and Fishing Methods

By far the greatest percentage of mackerel delivered to the fresh fish markets is taken by hook and line. The mackerel set line, drift line or long line, as it is variously called, accounts for most of the mackerel. Some boats fish with live bait, strikers or feather lures on short pole

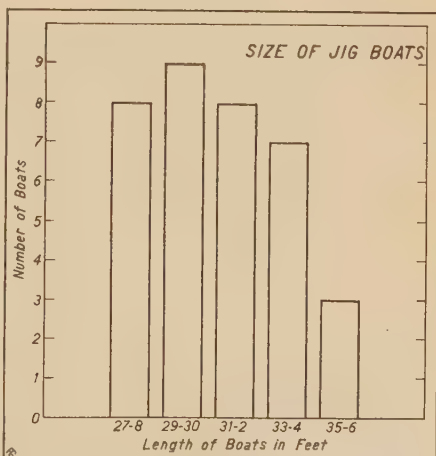


FIG. 21. Lengths of 35 of the typical Japanese jig boats engaged in the San Pedro fresh mackerel fishery. Bars show number of boats in each size range.

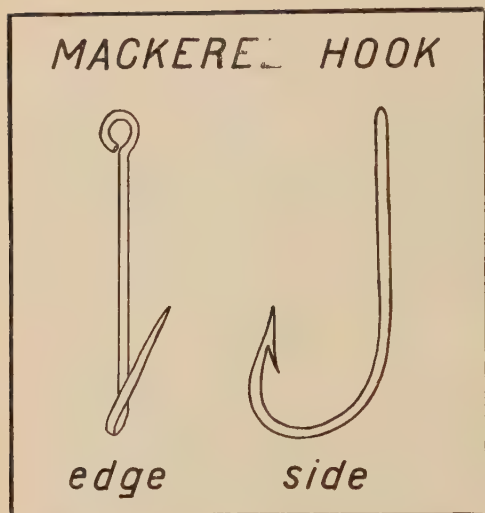


FIG. 22. Sketch of the type of hook (actual size) used by California mackerel fishermen. This hook is used on long lines at Monterey, San Pedro, Newport, and San Diego, and on hand lines at Monterey.

of $2\frac{1}{2}$ to 3 feet along the entire line, 18-inch snoods of hard-laid cotton line, size 12 or 15, are bent on the line. Each of these light lines bears a tinned hook, size 4/0 or 5/0. (See Fig. 22.) Thus each line has 400 to 500 hooks. The length of the line and the number of hooks vary considerably, depending upon the individual fisherman, but the above description applies to a typical San Pedro mackerel line. Both the main line and the hook lines or snoods are tanned, *i. e.*, treated with a boiled extract of tan bark that has the twofold effect of preserving the line and rendering it less visible to the fish. The hooks are baited preferably with pieces of fresh mackerel, or with small whole sardines or anchovies. Each line, except when it is actually being fished, is customarily carried coiled in a shallow wooden box with one side left open. (See Fig. 23.)

Each boat carries 4 or 5 lines. Several flag buoys are carried to mark the location of the line when set. Two types are in use. One consists of a bamboo pole bearing a red flag at one end and with a weighted line fastened to the other, and a small keg is tied to the middle to float the pole. The combination of the weight and keg serves to keep the flag end upright above the surface. The other type of marker consists of a similar bamboo pole and a red flag, but employs corks as a float. The corks are the standard round net floats, 4 to 6 inches in diameter with a hole in the center. Several corks are skewered on the pole and fastened to it a little nearer one end than the other. A piece of lead at the short or under-water end of the pole acts as a keel to keep the pole upright. Flag buoys are used to mark the ends of the line so the fisherman can find them after a set. Several small kegs

lines, as described on pages 75-76. Purse seines, ring nets, round haul nets or lamparas, gill nets, and trammel nets, all used regularly for the capture of other species, account for a few mackerel but not many.¹¹ The rough handling that fish receive when caught in a net is apt to bruise and spoil the rather easily crushed mackerel, so the dealers prefer hook and line caught fish which are generally handled carefully one at a time.

The set line is important enough to warrant a fairly detailed description of its construction and use. The line itself is of heavy cotton twine, medium hard-laid No. 60, 72 or 84. It averages about 1250 feet in length. At intervals

¹¹ For descriptions and fishing methods of these types of gear, see reports by Whitehead (1930) for gill net; page 72 of this report for purse seine; Clark (1931) for trammel net; page 98 of this report for lampara; and page 62 for ring net.

with lines attached and a number of large flat corks, roughly 18x18x3 inches, also with lines attached, complete the fishing equipment. Two or three boxes of 200- to 300-pound capacity are carried by each boat. It is in these boxes that the catch is kept. One man usually comprises the crew but two sometimes fish on one boat.

All the fishing is done in the early morning. There are two reasons for this. For one thing, the mackerel seem to be closer to the surface at sunrise than at any other time and are hence more readily available to the fishermen. Moreover, by fishing in the early morning on the nearby grounds the fishermen are able to get their fish to market early when the prices are highest. The boats leave their berths at Fish Harbor on Terminal Island, just across the channel from San Pedro, an hour or two before sunrise so they can be on the grounds in time for the best fishing.

As soon as the fisherman reaches the grounds he commences fishing. His past experience and observations of the operations of other boats lead to the selection of what he believes to be a likely spot. This is usually in open water just beyond the kelp beds and within a mile of shore.

His decision made, he cuts the motor to neutral and puts one of his flag buoys afloat. He fastens the end of one of the coiled fishing lines to the sinker on the buoy line and pays out the two lines over the stern of the boat. The sinker drags the hooks down to the desired depth. After paying out a hundred feet or so of line, he starts the engine at half speed and pays out a few hundred feet more of line before cutting the motor out again. He then checks the line and holds it for a minute or two to feel for bites. If no bites are detected he hauls in and goes somewhere else or sets his line at a different depth. If bites are felt, however, he continues setting out the line, alternately starting and stopping the engine every few hundred feet. By idling periodically he gives the line a chance to sink instead of trailing out behind on the surface, as it would do if he kept the boat moving.

After setting out about one-third of a line, the fisherman ties on the line that is fastened to one of the large corks and throws the cork overboard. This line is long enough for the cork to float the line at the desired depth. At the two-third mark, another cork

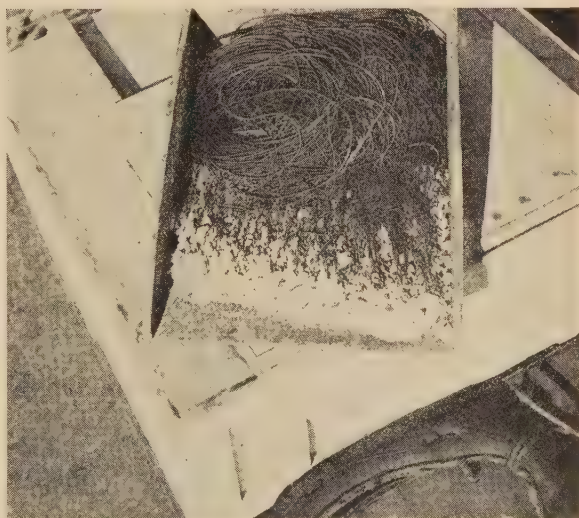


FIG. 23. San Pedro mackerel drift line coiled in tray ready for fishing. The baited hooks are covered with salt which preserves the bait. Photograph by author, October, 1931.

line is fastened. More than one line is nearly always used, so to the end of the first line a second is fastened. At this junction a line tied to a keg is fastened to the main line. (See Fig. 24.) This line is the same length as the ones fastened to the corks. The corks and kegs are tossed far out to the side of the line to avoid their fouling on the hooks. As the line sinks, it drags the buoys to a position directly above it. The set continues, each line being buoyed the same as the first one. At the end of the last line he has decided to set, the fisherman fastens a sinker, line and flag buoy combination and sets the buoy afloat. He then leaves that end of the line and turns back to pick up his first flag and haul in his gear. About one hour is required to set a gang of two lines. A diagram of a typical mackerel drift or set line is shown in Figure 24.

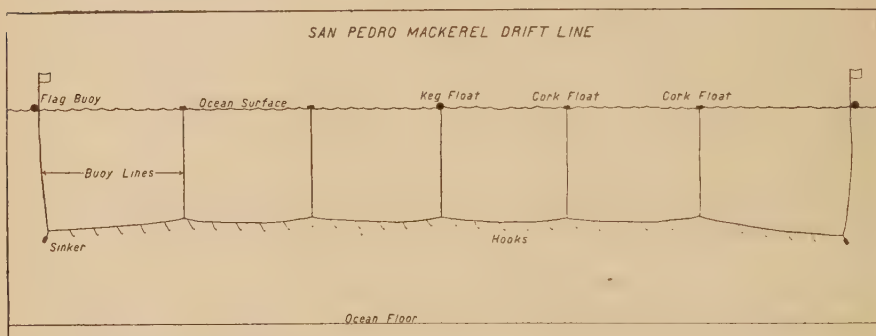


FIG. 24. Diagram of a San Pedro mackerel drift line in the water, as seen from the side. Not drawn to scale. This type of line is sometimes called "set line."

The line is always set parallel to the shore, often in a slight outward curve. It is necessary to set parallel to shore instead of at right angles in order to minimize the chances of the line being fouled by other fishing boats or steamers going up and down the coast.

The line is fished at varying depths, depending largely on the season. In general the mackerel remain farther below the surface in cold weather than in warm, so it is generally necessary to fish deep in the winter and fairly close to the surface in the summer. The average depth varies throughout the year from 30 to 75 feet. The line is never set on the ocean floor. At times the end buoy lines and the several cork and keg lines are of different lengths so the hooks are not all at one depth but cover a considerable vertical range.

The number of lines comprising a gang depends on the abundance of fish and the state of the market. If fish are scarce, the fisherman will set as many as four lines in a gang or perhaps five or six in two gangs. If fish are abundant and the market is poor, two or three lines suffice to catch a load that can be disposed of at a good price.

The line is left in the water only for the time it takes the fisherman to return from the last flag buoy to the first one. He hauls the buoy with its line and sinker aboard, throws them to the side out of the way and commences to haul the line in over the stern by hand. He piles the line loosely in the same wooden tray in which it had been so carefully coiled before setting. He removes the fish from the hooks with

a jerk, tearing the hooks loose rather than extracting them carefully. He throws the large salable mackerel into the big boxes and the small ones onto the deck to be cut for bait later. The horse mackerel, kingfish, bonito, and other fish that sometimes take the hook are put aside to be sold separately. Most of the fish are exhausted by their struggles to free the hook and can be easily handled.

While hauling in the fish-laden line, the fisherman alternately starts and stops the engine as when setting the line. The boat is headed toward the second buoy, but at a slight angle from the direction of the line. This causes that part of the line that is nearest the boat to bell out astern while the boat runs alongside the line that is still set instead of running over it and getting fouled. (See Fig. 25.) The drag of the line pulls the boat back toward the line during those intervals when the engine is idling in neutral. Each one of the lines in the gang is loosely coiled or piled in a separate box. The kegs and corks, with their lines which have been cut free from the main line, are thrown in a pile to be untangled later. The amount of time required to haul the line depends on the numbers of fish that have to be removed from the hooks. In any event it takes about as long to haul the line as it does to set it.

The line and the catch aboard, the boat heads back to San Pedro. On the way in the fisherman prepares his bait for the next day. The small mackerel lying on the deck are utilized. Wielding a sharp knife, the fisherman slices the sides away from the backbone. The backbone with the head attached goes overboard to the pelicans. The sides go into a box where they are salted to toughen and preserve them. They can be used any time up to three or four days after salting. When baiting the line, the fisherman cuts the sides into smaller pieces to fit the hooks. Each half of a small mackerel yields 8 to 10 baits.

The first problem that confronts the fisherman on his arrival at the municipal wharf is that of finding a place to tie up. Usually there is a solid row of all sorts of fish boats discharging their fares or taking on ice and provisions. It is often difficult for the little mackerel boats to squeeze in between the big purse seiners and tuna cruisers. After tying up, the fisherman must find buyers in the markets. In most cases

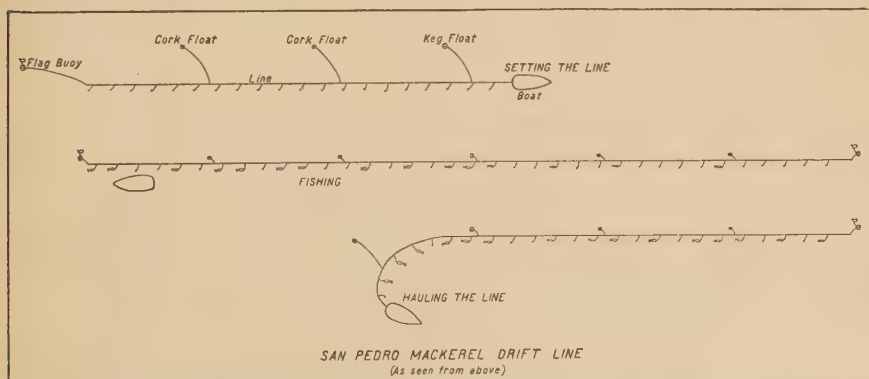


Fig. 25. Diagram of a San Pedro mackerel drift line, as seen from above. Not drawn to scale. Upper sketch shows boat setting the line; middle shows line completely set and boat returning to pick up first flag buoy; lower shows boat hauling in the line over the stern.



FIG. 26. Japanese fisherman hauling in a drift line and removing mackerel from the hooks. Photograph by author, off San Pedro, October, 1931.

each boat fishes for one dealer who nearly always takes at least a part of its catch. In order to sell the surplus, the fisherman must find a buyer in another market. When the mackerel deliveries are heavy, the last boats in have difficulty in disposing of their catches for a price. On the rare occasions when a net boat dumps a great many mackerel on the markets for a low price, the setliners are out of luck entirely. Usually, however, enough of the catch can be sold to defray expenses at least.

As soon as buyers are secured, unloading commences. Men on the wharf lower a rope from a hand winch and one of them clambers down to the boat and fastens the rope to a box of fish. There are always willing hands to hoist the box,

swing it onto a truck and push it into the market—in return for a few mackerel or kingfish. All the fisherman has to do in unloading is to superintend the job and hand out fish to the members of the make-shift unloading crew. The helpers, a motley gang of all nationalities, peddle what fish they can to water front visitors and take the remainder home to eat. The fish that they get are the smaller ones that the fishermen can not sell to the dealers.

Following the sale of the fish and unloading them, comes the return to Fish Harbor and the preparation for the morrow's fishing. After fishing, the lines are in a terrible mess due to the gyrations of the active mackerel when first hooked and to the haste of the fisherman in hauling them aboard. It requires a full afternoon of hard work to untangle, recoil and bait two or three lines. Often the wives and children of the Japanese fishermen help with this work, which is done ashore on Terminal Island where the fishermen live.

Horse Mackerel

As pointed out previously, a discussion of the mackerel fishery can not hope to be complete without frequent references to the horse

mackerel. (See p. 16.) This is particularly true of the Los Angeles mackerel fishery.

Los Angeles County is the leading district of the State in horse mackerel landings. (See Fig. 16.) For the period from 1928 to 1930, inclusive, 90 per cent of the total California horse mackerel catch was landed in Los Angeles County ports. With an average yearly delivery of about 440,000 pounds to the San Pedro fresh fish markets, the horse mackerel is fifth in importance of the locally caught market fish. (See Fig. 18.) Although there is no great demand for the horse mackerel, the fishermen are able to sell all they can catch. The horse mackerel seems to be scarcer than the Pacific mackerel and there is seldom a glut of these fish on the market.

The horse mackerel commands a higher price than the mackerel, because it does not spoil so readily and is said to have a better flavor and also because it is scarcer and therefore more desirable. A common fish is nearly always scorned and an uncommon one often valued above its worth. The price paid to the fishermen varies from 2 to 6 cents per pound.

Horse mackerel seem to be scarce in the spring, few coming into the markets during March, April and May. Throughout the rest of the year, landings are fairly constant.

The same boats, fishing in the same places with the same gear, take both mackerel and horse mackerel for the markets. In addition to the hook and line boats, which really fish for mackerel in particular and take horse mackerel only incidentally, some of the ring net boats fishing for miscellaneous market fish deliver occasional fares of horse mackerel. The ring net boats fishing mackerel for the canneries sometimes encounter schools of horse mackerel, make catches and sell the fish to the wholesale markets for a much higher price than any mackerel they might catch would command at the canneries. Horse mackerel are not so easily bruised by a net as the Pacific mackerel and are in any event relatively scarce, so the fresh fish dealers are willing to accept net-caught horse mackerel. A description of the ring net boats and their methods of fishing can be found on pages 58-72.

Summary

The foregoing pages have acquainted us with a number of facts, the most important of which are repeated: With an annual catch of over 2,250,000 pounds, the mackerel is the second most important of the local fresh fish landed in Los Angeles County. The horse mackerel with an annual catch of nearly 500,000 pounds is fifth. This county, with San Pedro as the center, is the leading mackerel district of the State, as well as the leading horse mackerel district. Mackerel brings 2 cents a pound and horse mackerel about 4 cents a pound to the fishermen. The mackerel is an all-year fish, with a relatively constant supply at all times to meet a steady demand. The fishing grounds are within a few miles of San Pedro. The mackerel fleet of about 20 craft consists mainly of 30-foot "jig boats" that use as gear a long drift line bearing several hundred baited hooks. Most of the market mackerel fishermen are Japanese.

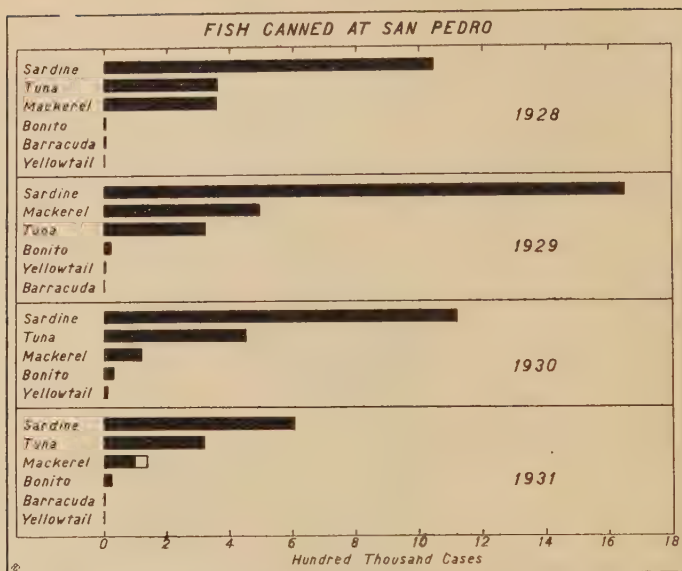


FIG. 27. Number of cases (converted to cases of 48 one-pound cans) of all kinds of fish packed in the San Pedro district by years, 1928-1931, inclusive. Figures include fish packed in Los Angeles County and at Hueneme and Newport. "Tuna" includes four species—albacore, bluefin tuna, skipjack (striped tuna), and yellowfin tuna. Barracuda is canned as fish cakes. White portion of mackerel bar for 1931 represents animal food made from mackerel.

Mackerel Canning Industry

Extent of Industry

The canned mackerel industry of Los Angeles Harbor has definitely taken its place alongside the longer established sardine and tuna industries. A practically unknown commodity in 1927, canned mackerel is now the third most important canned fisheries product of California. With the exception of a fair pack at San Diego in 1929, very little mackerel has been canned in California outside Los Angeles County. (See Table 3.) At Los Angeles and for that matter the State as a whole, only sardines and tuna exceed the mackerel in production; all other fishes trail far behind. (See Fig. 27.) The mackerel pack of Los Angeles County alone far exceeds the total California pack of abalone, barracuda (fish cakes), bonito, salmon, shad, shad roe, squid, yellowtail, and all the mackerel packed at other ports, in fact, everything except sardines and tuna.

In no one year previous to 1927 had more than 6000 cases of mackerel been packed in the San Pedro district. No one had ever perfected packing methods or tried to build up a market. In 1927, one of the San Pedro cannerys perfected both packing technique and marketing methods. The 1927 output was a little over 10,000 cases. Many other packers took advantage of the pioneer's ideas, and 1928 saw a production of 360,000 cases. The next year topped that figure by 140,000 cases to set a new record. (See Table 3.) The truly phe-

nominal production of 1928 and 1929 could not be expected to continue. A curtailed world market because of international depression, the big competitive salmon and sardine packs, in fact, the overproduction of mackerel in 1929, all pointed to a diminished output in 1930. The production did drop markedly, but the 120,000 cases packed in 1930 were enough to keep the mackerel in third place among the canned fish of not only Los Angeles County but the entire State.

The mackerel packers of 1928 and 1929 made good profits. Many saw the handwriting on the wall and suspended their mackerel operations after pocketing a profit. Those who have continued to pack have not enjoyed such large returns due to the curtailed market and the prevailing low prices of canned goods. They have been able, however, to make a little above expenses, and what is perhaps more important, they can afford employment to many fishermen and cannery workers who would otherwise be idle. About 3000 men and women find seasonal employment at the fish canneries of the San Pedro district. Most of these were formerly out of work during those times that the canners were not packing sardines or tuna. As the mackerel are available throughout the year, the canners are able to pack them during the slack times between tuna boat arrivals and during the closed season on sardines, and consequently can keep their cannery crews at work more of the time. Besides the cannery crews, many fishermen who would otherwise have been unable to sell fish, benefited from the packing of mackerel. During the lean year of 1931, most of the sardine and tuna boats were forced to lie idle a great deal of the time because the canners

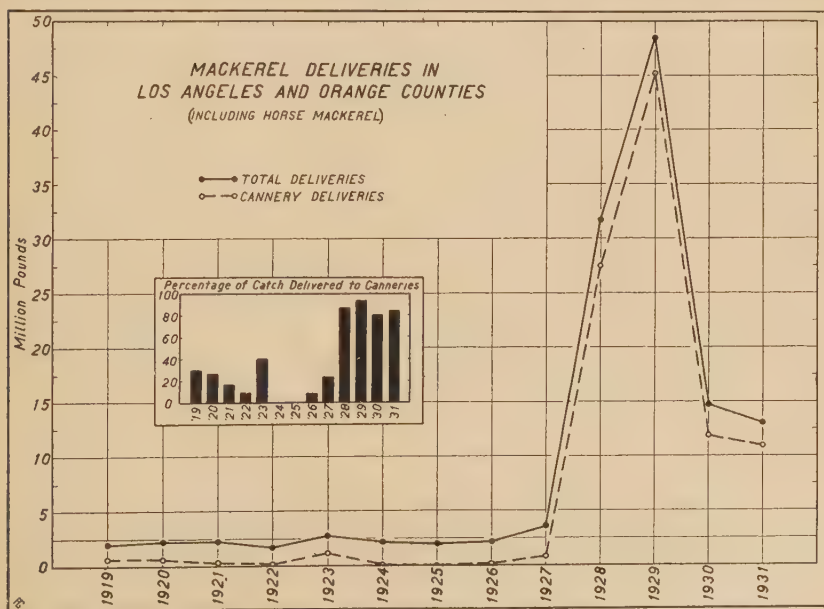


FIG. 28. Mackerel deliveries (including horse mackerel) in Los Angeles and Orange counties combined, by years for the period 1919-1931. The dotted line shows amounts of fish taken by canneries. The fresh fish deliveries can be determined by subtracting cannery deliveries from the total landings.

did not care to pack sardines or tuna at a loss. If a few cannerys had not been able to pack mackerel during that year more boats would have been scrapped and more grocery bills gone unpaid.

Location and Number of Canneries

The mackerel cannerys of the San Pedro district can be divided geographically into four groups, three of which are in Los Angeles Harbor. These three are: San Pedro proper, Wilmington and Terminal Island. The other group is in Long Beach. The San Pedro cannery is situated near the entrance to the inner harbor; the Wilmington cannery is in Slip 5 near the Catalina Terminal; the Terminal Island cannerys are located on Cannery Row, Fish Harbor; and the Long Beach cannerys are in Long Beach Harbor.

The number of plants in each group packing mackerel varies from year to year. The following table shows the number of mackerel cannerys in each location by years:

<i>Year</i>	<i>Long Beach</i>	<i>Wilmington</i>	<i>San Pedro</i>	<i>Terminal Island</i>	<i>Total</i>
1927-----	1	1	--	1	3
1928-----	1	3	1	5	10
1929-----	2	3	1	6	12
1930-----	--	1	1	5	7
1931-----	--	1	1	2	4

Some of the cannerys that have ceased packing mackerel, for the time being at least, have done so because of economic reasons. The owners decided that canning mackerel during a period of depression would not result in a profit. Two of the Wilmington firms were forced to abandon their plants when the Los Angeles Harbor Commission decided to build steamship terminals on their sites. They subsequently merged with a Terminal Island cannery. One of the Terminal Island plants lost its identity when it was purchased by another.

In addition to the above list of cannerys, one plant at Newport, Orange County, packed mackerel during the spring of 1930, and a cannery at Hueneme, Ventura County, put up some mackerel in 1931. These cannerys can be considered in the San Pedro district in a sense as they draw on the same fishing area for their fish.

None of the mackerel cannerys was built expressly for packing mackerel. They are all primarily tuna and sardine cannerys. In some cases the sardine lines have been modified to handle mackerel, while in others specially built mackerel lines have been installed.

Price Paid to Fishermen

The prices that the cannerys pay for mackerel vary from time to time but they are always constant as between cannerys, and always much lower than the fresh fish markets pay. The cannery fishermen can afford to accept a lower price because of the greater amounts they can sell.

In the early months of 1928, when no more than one or two cannerys were operating, a price of \$15 per ton was paid to the fishermen. As the other firms took up the business, they all had to bid higher in order to get boats to fish for them. The price rose to \$25, \$30, \$35, and even \$40 a ton for a brief period. During the summer of 1928 the

price was stabilized at \$30 per ton, at which figure it remained until September, 1930. At that time, as a result of the decline in price of canned mackerel from the 1928 figure of \$4.25 to \$2.90 per case, the canners cut the price to \$15 a ton and shortly afterward to \$10. That low price held for the remainder of 1930 and all of 1931, although some of the canners tried to cut it to \$7.50 as the price of canned mackerel continued to drop.

Fishing at \$30, the fishermen made good money. At \$10 they could scarcely make a living but many preferred to continue fishing rather than starve. Most of them objected strenuously to the price cutting, but it was not long before many of them were begging to be allowed to fish for the lower figure.

Seasons

The canned mackerel industry is such a recent thing that it is scarcely possible to draw any definite conclusions about seasons.

The mackerel is available in southern California waters at all seasons as is shown by the fact that the hook and line boats fishing for the fresh fish markets can make nearly constant catches throughout the year. However, the cannery net boats usually have difficulty in finding any numbers of fish during the months of March, April and early May. The fishermen report that the high winds prevalent during those months kick up waves and muddy the water, making it difficult to locate schools. Food, such as copepods, is abundant during the spring, and the fish are often too well fed to come to the bait according to the fishermen.

With the exception of the spring months which always show a light pack because of the apparent scarcity of fish, the season depends upon when the canners themselves want the fish, so the peak is apt to occur at almost any time. (See Fig. 29.)

Fishing Grounds

The region in which the San Pedro cannery mackerel fishermen operate is rather extensive. The extreme limits of the fishing grounds are Anacapa Island in the west, San Clemente Island in the south, and Point San Juan in the east. (See map, Fig. 30.) The limits of the most heavily fished area are marked by Point Dume, Santa Catalina Island and Newport Beach. This central fishing area can well be divided for the purpose of this discussion into four sections as shown on the map (Fig. 30). The division lines are arbitrary as the boats do not always confine their activities on any one trip to one section. However, the boats usually do set out for a special fishing area and concentrate on it.

As shown on the accompanying map, the section referred to as No. 1 extends along the coast from Point Vincente to Long Beach and seaward about 10 miles. Section No. 2 includes the waters around the west end of Santa Catalina Island. The east end of the island is closed by law to all net fishing. Section No. 3 consists of the waters lying within about 10 miles of shore between Seal Beach and a little south of Newport Beach. Section No. 4 lies just outside Santa Monica Bay between Rocky Point and Malibu Point. Until August, 1931, Santa Monica Bay itself was a much frequented mackerel fishing area, but at

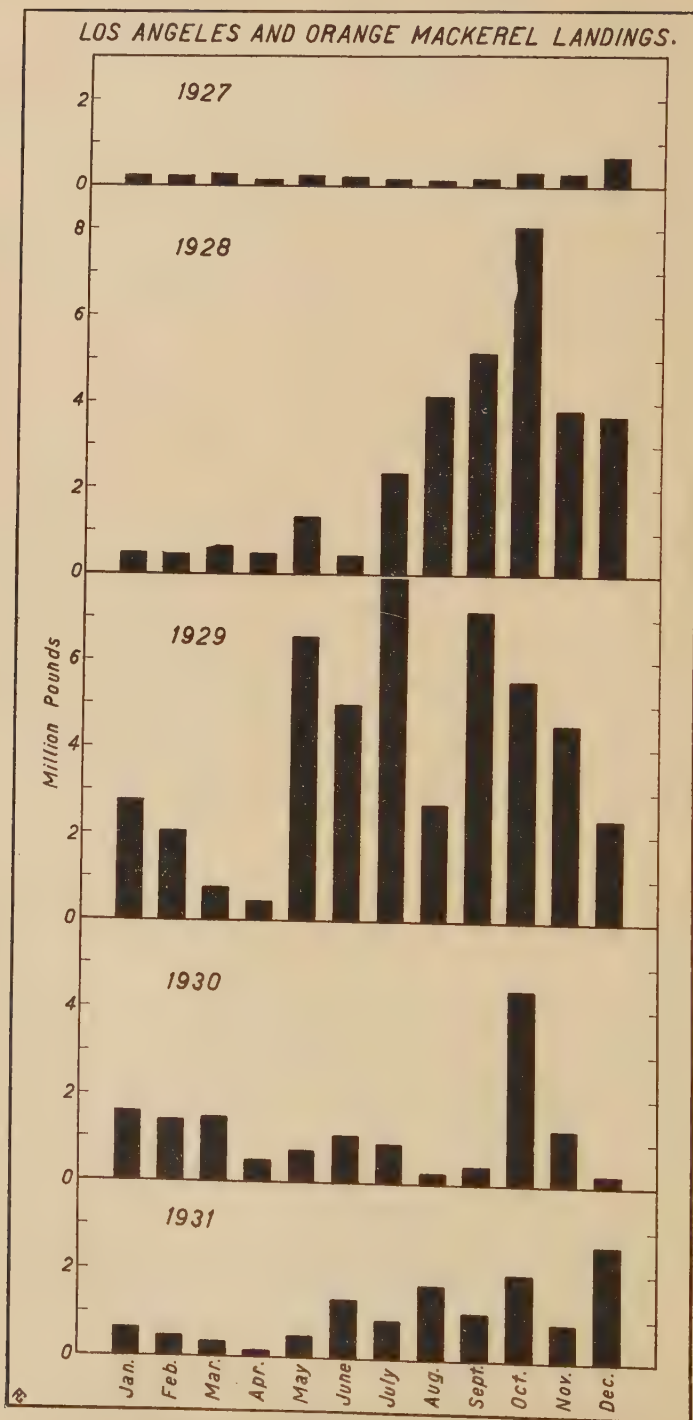


FIG. 29. Mackerel deliveries (exclusive of horse mackerel) in Los Angeles and Orange counties by months for the period 1927-1931.

that time the bay was closed by the State Legislature to net fishing except for bait.

Weather conditions and the success or failure of other boats lead to the fishermen's choice of a particular fishing area. The success of the fishermen at one place or another varies greatly from week to week, but there is no definite season in one locality any more than in another.

Partly because of its proximity to the canneries, section No. 1 is the most popular fishing region. The boats that have no success in the locality of Point Firmin, Portuguese Bend, Whites Point, or Point Vincente have the additional chance of making a catch by pushing on into the Santa Monica Bay or Catalina Island regions. Because of the relatively long trip to Point Dume or Catalina and the consequent consumption of fuel and loss of time, the boats never make for these areas unless fish have been scarce on the nearer fishing grounds during the preceding days. Many additional catches can be credited to section No. 1 because the boats headed for distant grounds often stop and fish if they see mackerel while passing through. The boats that head for Newport have to risk everything on one locality. Nevertheless, the waters off Huntington Beach and Newport Beach are second in popularity only to the Point Vincente grounds.

The distant fishing grounds around Anacapa, Santa Barbara, San Nicolas and San Clemente islands are not regularly frequented by the

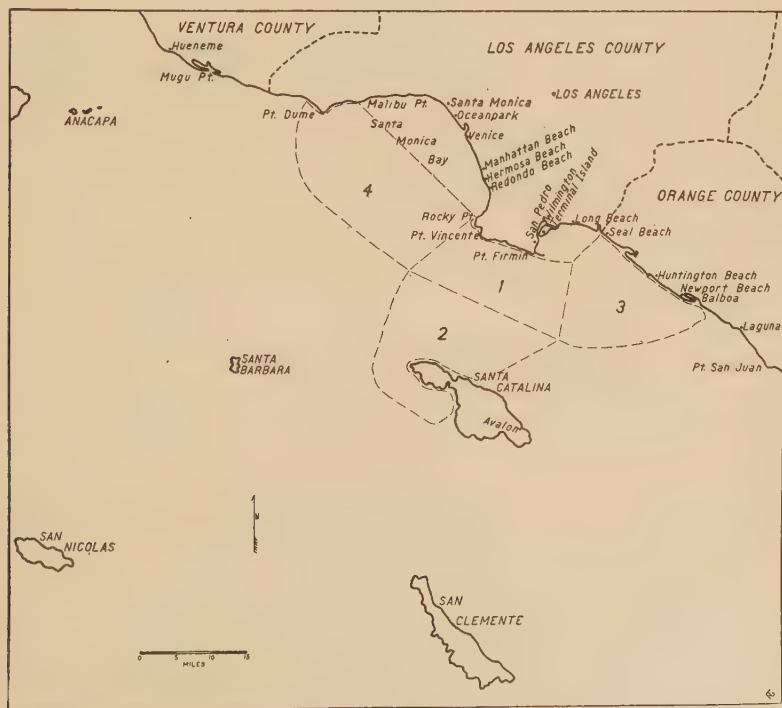


FIG. 30. The area frequented by Los Angeles and Newport mackerel boats. The waters (areas 1, 2, 3, and 4) enclosed by the dotted lines are the most popular fishing grounds.



FIG. 31. San Pedro purse seine boat with ring net. This boat is 59 feet long and is powered with an 80-horsepower diesel engine. Photograph by D. H. Fry, Jr., January, 1931.

San Pedro mackerel boats. The catches that are made there are taken either by sardine boats or by boats seeking yellowtail, bonito and barracuda. Sometimes the canneries tell their crews to bring back mackerel if no other fish can be found, and as mackerel seem to be abundant around the islands the boats often return with large mackerel fares.

The approximate distances in nautical miles (6080 feet) from Fish Harbor, Terminal Island, along the main courses of navigation to specific points in the mackerel fishing area are as follows:

Point Vincente.....	12 nautical miles
Newport Beach.....	23 nautical miles
Santa Catalina Island (west end).....	25 nautical miles
Point Dume.....	36 nautical miles
Point San Juan.....	40 nautical miles
Santa Barbara Island.....	43 nautical miles
San Clemente Island (west end).....	52 nautical miles
San Clemente Island (east end).....	56 nautical miles
Anacapa Island.....	60 nautical miles
San Nicolas Island.....	67 nautical miles

Boats and Fishermen

There are three main types of boats engaged in the cannery mackerel fishery at San Pedro. All the boats use one or another of two types of encircling nets, called purse seine and ring net, for capturing the fish and must consequently be large enough to carry a heavy net as well as a load of fish. Various types of hook and line boats formerly figured in the cannery mackerel fishery. They passed out of the picture in 1930. They were nearly all jig boats and fished as described on pages 45-50. Some of them fished live bait style as described on pages 75-76.

The boats of the largest of the three net types are known as purse seiners. A typical purse seine boat is shown in Figure 31. Most of the

purse seiners were originally built either in the State of Washington to fish for salmon and Alaskan herring, or at San Pedro to fish for tuna, barracuda and sardines. They range in over-all length from 53 to 80 feet and in beam from 14 to 20 feet. The net tonnages range from 25 to 60. Those built since 1928 are over 70 feet in length. The majority of the boats, however, are older and smaller. Many of them were built during a purse seine boom in 1918-1919. The most popular size range at that time was 64 to 69 feet, and boats of those sizes still predominate in the purse seine fleet. (See Fig. 32.)

The purse seine boats have hold capacities of 20 to 100 tons of fish, and total capacities, including deck loads, of 60 to 140 tons. Practically all of them are powered by diesel engines. Of the 20 boats represented in Figure 32, one uses distillate as fuel and one gasoline, whereas all the others use diesel oil. The diesel engine is favored because of its greater economy and safety. The one gasoline-powered

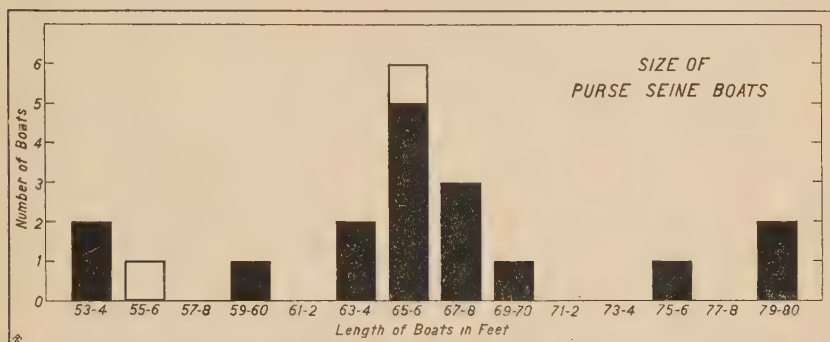


FIG. 32. Lengths of the purse seine type boats fishing more or less regularly for San Pedro mackerel canneries during the period 1929-1931. Black square indicates diesel engine, white indicates gasoline or distillate engine. Twelve Japanese crews, four Italian crews and four Slavonian crews are represented.

boat recently burned and sank as a result of a backfire igniting gasoline in the bilge. The indicated horsepower of the diesel engines varies from 60 for the smallest boats up to 185 for the largest. These engines give the boats speed of from 6 to 10 knots per hour.

A purse seine boat may carry either a purse seine or a ring net. The Japanese and Italian crews that fish mackerel regularly prefer the ring net. The Slavonian and Japanese crews that fish more or less incidentally for mackerel, while primarily interested in sardines or barracuda, usually employ the turntable purse seine.

There are sleeping accommodations aboard for the entire crew. When fishing for mackerel the purse seine boats carry crews of from 9 to 12 men. The number in a crew varies, depending upon the type of net and the nationality of the fishermen. In general, less men are carried by boats using purse seines than by those employing ring nets. A number of labor saving devices are used in the operation of a purse seine, so less men are needed to haul it. Because of the smaller stature of the Japanese fishermen, more of them are required to haul a net than the heavy Europeans, so Japanese boats usually carry more men.¹²

¹² For a detailed description of a purse seine boat, see Whitehead (1931, pages 10-14).

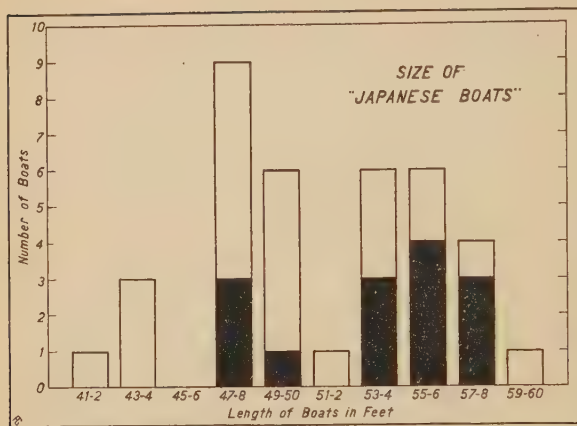


FIG. 33. Lengths of the "Japanese ring netters" that fished regularly for San Pedro mackerel canneries during the period 1929-1931. Black square indicates diesel engine, white indicates gasoline or distillate engine. Thirty-six Japanese crews and one Russian crew are represented.

The two smaller types of boats are far more important in the mackerel fishery than the purse seiners. Not only are there more of the small boats, but they fish more consistently for mackerel, devoting less time to other species. There are (1929-1931) about 55 boats that can be considered as regular mackerel fishermen under the general classification of "smaller than purse seine boats."¹³ Fifty of these smaller boats can be classified

as belonging to one or the other of two distinct types. There is no one name in common use that can be used when referring to either type, so for the purposes of this paper we shall have to invent names. The remaining five are assorted in-between types, some of them built somewhat on the lines of small purse seiners.

The most numerous group of the smaller craft consists of boats that were built for Japanese fishermen during the early years of the big summer albacore runs, about 1918-1922. The Japanese fished for albacore with hook and line during the summer and filled in the winter by fishing for sardines with round haul nets. Because the boats were built primarily for albacore fishing, they are sometimes called albacore boats. However, confusion with albacore fishing results from the use of this term so another must be devised. These boats were originally built for Japanese fishermen and are all equipped with ring nets for cannery mackerel fishing. Therefore, for the purpose of this paper, the term "Japanese ring netter" will be used when referring to this type of boat.

The Japanese ring netters range from 41 to 60 feet in total length and 10 to 14 feet in beam. The majority are 47 to 58 feet long. (See Fig. 33.) Net tonnages range from 5 to 14.

This type of boat has a pointed, wedge-shaped bow, rounded stern, straight sides with little flare, and a comparatively flat deck. The pilot house and engine room are amidships. In addition to the inside engine and steering controls there are controls atop the pilot house. Just astern the engine house there is a mast with a boom. The net is carried in a pile at the stern. Sleeping quarters for part of the crew are below the forward deck. These boats were built to be handled by fewer men than are carried for mackerel fishing, so when a mackerel

¹³ It must be understood that these boats did not all fish for the entire 3-year period. Some of them did, but many fished in one or two years only. All the boats that made either a large number of catches in one year or a scattering of catches through all 3 years are included to make the total of 55.

crew wants to catch a little sleep, some of the men have to curl up on the floor of the forecastle or on deck. Most of the boats have cargo holds astern with capacities ranging from 5 to 12 tons of mackerel. A few of the smaller boats have no holds but must carry their entire loads on the deck. Sideboards are often built above the gunwale so large deckloads can be carried. Total capacities of the Japanese ring netters range from about 15 to 60 tons, although the Japanese boats seldom deliver mackerel fares over about 20 tons. Figure 1 shows a typical Japanese ring netter.

Of the 37 boats represented in Figure 33, 14 are powered with diesel engines, 22 are driven by gasoline engines, and 1 burns distillate as fuel. The indicated horsepower range of the diesel engines is 40 to 60. The horsepower of the gasoline engines varies from 35 for the smallest boats up to 65 for the largest. All recent replacements have been with diesel engines due to the greater safety and economy of that type of power. The maximum speeds of the boats are 6 to 9 knots per hour.

Nearly all the Japanese ring netters are manned at present, as always, by Japanese fishermen. Of the 37 boats under discussion 36 have Japanese crews and 1 is operated by Russians. A mackerel crew for this type of boat consists of 7 to 10 men, depending on the size of boat and net. There are not sleeping accommodations for a full crew on any of the Japanese ring net boats but protracted cruises are not necessary in mackerel fishing so that lack is not a serious handicap to successful operation.

The smallest of the three types of mackerel craft is represented by a fleet of 13 boats. The boats were all built many years ago for Italian fishermen who originally used them solely for fishing for the fresh fish markets with gill nets and lamparas. When sardine canning rose to major importance at San Pedro in 1917, the Italian fishermen turned to sardine fishing to supplement their general market fishing. Then when the mackerel skyrocketed to a leading place in 1928, the

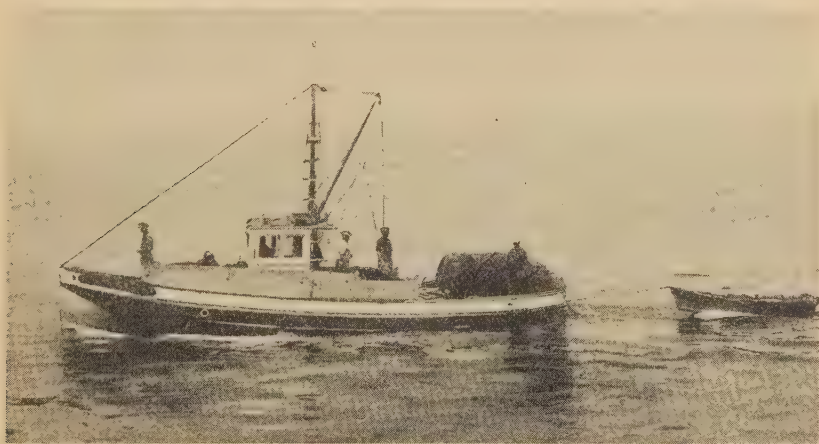


FIG. 34. San Pedro Italian ring net boat on the fishing grounds. This boat is 40 feet long and is powered with a 30-horsepower gasoline engine. Photograph by G. H. Clark, 1930.

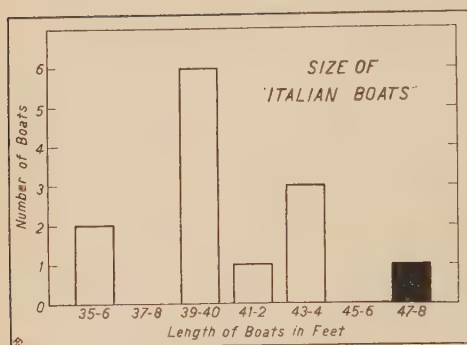


FIG. 35. Lengths of the "Italian ring netters" that fished regularly for San Pedro mackerel canneries (1929-1931). Black square indicates diesel engine, white indicates gasoline engine. All boats manned by Italian crews.

same Italians, who had found their boats too small to compete with the purse seiners that had recently entered the sardine fishery, equipped their boats with ring nets and went mackerel fishing. Because the boats were constructed for Italians and use ring nets for catching mackerel, we shall hereafter refer to them in this paper as "Italian ring netters."

The Italian boats range in total length from 35 to 47 feet and in beam from 9 to 11 feet. Nearly all of them are 40 to 43 feet long. (See Fig.

35.) Net tonnages are all 5 or less except for the largest boat which boasts of 6. The Italian ring netters are similar in appearance to the Japanese type boats. In general, however, they are narrower and their decks are closer to the water. The cabins of the Italian type boats are relatively smaller and there are no steering and engine controls atop some of them. All the Italian boats have holds, capable of carrying 3 to 10 tons of mackerel. Total capacities range from 12 to 20 tons, the maximum depending upon the daring of the individual captain. Given the same boat to load, one captain will pile on 17 tons whereas another will hesitate at 13 or 14. A typical Italian ring netter is shown in Figure 34.

All but one of the Italian boats are powered with gasoline engines, many of them the original installations of over 15 years of service. The gasoline engines range from 20 to 35 horsepower. The largest boat of the group installed a 30-horsepower diesel engine in 1930. The boats are not speedy, 5 or 6 knots per hour being their maximum.

The Italian ring netters are all manned by Italians. In several instances the original crews are still operating the boats. The crews consist of 7 to 9 men including the captain.

From the foregoing it can be seen that Japanese and Italian fishermen predominate in the mackerel fishery at San Pedro. Besides those two nationalities there are a few Slavonian crews that fish only occasionally and one consistent Russian crew. The 5 boats mentioned above as not fitting into any of the three major types of boats were manned by a varied assortment of nationalities, including Scandinavians, Japanese, Frenchmen, Italians, Slavonians, and Americans. They have done practically no mackerel fishing since 1929, however, with the exception of one Japanese-manned boat that still fishes.

Construction and Operation of the Ring Net

The ring net¹⁴ is a light weight, high speed form of purse seine

¹⁴ The net known variously as the ring net, half ring net, or purse lampara will be designated ring net in this report as that name is the most descriptive. The term half ring net is correctly applied to a net with rings on the bag—or half the net—only, such as was used several years ago. Purse lampara is the name of a definite type of lampara with rings, an unsuccessful net that is not used now although the name persists to some extent.

or pursed encircling net. It is used by all three types of cannery mackerel boats—Italian ring netters, Japanese ring netters and purse seine type boats—and is the only type of gear used by the first two. Small boat fishermen developed it to compete with the purse seine which threatened to run them out of the sardine fishery in 1926 due to its superiority over the lamparas they had formerly used. It is in effect a compromise between the lampara and the purse seine,¹⁵ combining the light weight and negligible bulk, the speed and the low cost of the former with the positive action of the latter.

The ring net is made of tanned cotton webbing of various sizes of mesh in the form of a huge rectangle. It is so constructed as to hang vertically in the water with a row of corks to float the upper edge at the surface and a row of sinkers to keep the lower edge down. There is a series of rings along the lower edge which can be pursed together with a purse line to close the bottom of the net after it has been circled.

The seine consists of three parts—the central “bag” of small mesh webbing, and the two “wings” of coarse mesh webbing. The relative lengths of bag and wings vary greatly depending on the ideas of the owners. The total lengths of mackerel ring nets range from about 125 fathoms for those carried on the smallest boats up to 250 or more fathoms. The depths range from about 20 to 40 fathoms.

The cork line is strung with disk-shaped corks, 4 to 6 inches in diameter and 2 to 3 inches thick. These are placed in bunches of 2 to 4 with spaces between for hand-holds and for fastening the webbing to the line. There is generally one of these groups every 18 inches along the line supporting the bag. The cork line on the wing often carries less corks as it does not have to support so much weight. Between the cork line and the main body of the net there is a narrow strip of extremely heavy webbing, called selvage, which is fastened to the cork line between bunches of corks by pieces of heavy twine. The selvage distributes the strain, imposed by the weight of the net hanging from widely spaced supports, over the entire length of the lighter webbing to which it is laced.

The lead line is strung with egg-shaped, 4-ounce sinkers 3 to 6 inches apart. The galvanized iron purse rings, 5 to 6 inches in diameter, are fastened to the lead line by means of bridle lines. These are 15-foot pieces of rope lashed at their two ends to the lead line at points about 13 feet apart. The ring is fastened to the middle of the bridle line and hangs several feet below the lead line. (See Fig. 36.) The bridle lines are some distance apart so that the rings are spaced at intervals of 20 to 25 feet along the bag and are considerably farther apart on the wings. A purse line of manila hemp rope, $2\frac{1}{4}$ to $3\frac{1}{4}$ inches in circumference, runs from one upper corner of the net through all the rings to the other upper corner. This rope is in 2 or 3 pieces fastened by links as an aid in recoiling between hauls. There is a strip of very heavy webbing between the lead line and the main body of the net to take up the strain that is exerted, when the rings are pursed, at the points where the bridle lines are fastened.

The net itself is made of many strips of webbing placed vertically in the wings and either vertically or horizontally in the bag and laced

¹⁵ Description of a lampara is given on page 98. Description of a purse seine is given on page 72.

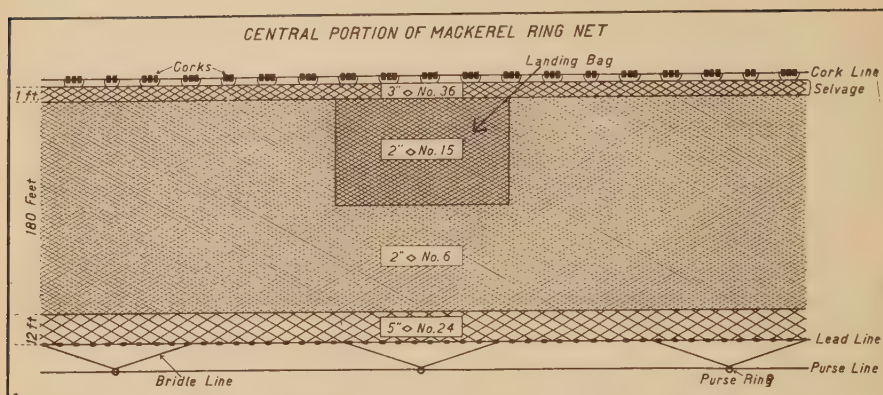


FIG. 36. Diagram of the central portion of a mackerel ring net. Not drawn to scale. Diamond is symbol for mesh.

together. The greater part of the bag consists of 2-inch mesh (stretched web measure), 6-thread, medium hard-laid webbing. On the upper edge of the bag there is a piece of heavier, finer meshed webbing 10 to 16 fathoms square, in which the fish are concentrated at the end of the haul. This is known as the landing bag or brailing piece. The lead line on the bag is somewhat shorter than the corresponding cork line and consequently the bottom of the net tends to act as a sort of scoop. To make the bag hang deep and bulge out behind the lines when hauled, the webbing is 15 to 30 per cent longer than the cork line and hung correspondingly loose.

The wings are made of vertical strips of webbing of several mesh sizes, ranging in some nets from 4 inches next to the bag up to 8 or 10 inches at the end of the net. The wing is as deep as the bag where it joins the bag but toward the end it tapers a little. At the end of the net the webbing is gathered, bringing the lead line up to the cork line to which it is fastened.

The wings of the mackerel ring nets used on large boats are often quite short, the long bags comprising most of the net. Some of the smaller boats have long-winged nets with relatively short bags. The long wings increase the size of the effective circle that can be made without adding much to the weight or bulk of the net when piled on the small craft.

The mackerel nets with bags of 2-inch mesh can be successfully used for barracuda and white sea-bass. Many fishermen owning sardine ring nets with bags of $1\frac{1}{4}$ - or $1\frac{1}{2}$ -inch mesh use them for mackerel fishing as they are. The finer meshed webbing can not be pulled through the water fast enough for the best success in trapping the active mackerel, however, so some fishermen keep special 2-inch mesh bags that they use in connection with their regular pair of wings when fishing for mackerel.

Some action must be taken by the fishermen to protect their cotton nets from the fish slime that would otherwise rot them. Before using a new net, therefore, they tan it. Every cannery owns one or more tanning tanks or vats. The fishermen boil 5 or 6 sacks of tanbark for about two hours in the tank owned by the cannery for which they are

fishing, allow the liquid to cool a bit and soak the net in it for several hours. Not only does this action preserve the net but it stains it brown, making the previously white twine semi-invisible in the water. In addition to the original tanning, the net must be retanned every 2 to 6 weeks during the fishing season. Before retanning, the fishermen remove the net from the boat and spread it out to dry. While it is drying they take the opportunity to mend any holes that have appeared. After every day's fishing, the ring net should be rinsed and salted as temporary preservative measures. Rinsing is accomplished by towing the net behind the boat or making a dummy haul. After every haul the net must be repiled, so after the last haul of the day while most of the crew is repiling the net, one or two men throw handfuls of salt on the net, particularly on the bag where the slime is heaviest. (See Fig. 37.) Some fishermen salt and rinse their seines at intervals of several days but it should be done daily as mackerel slime is especially injurious to the cotton webbing. The fishermen buy the tanbark and salt from the cannery to which they deliver their fish.

The ring net is carried in a pile at the stern of the boat. Japanese crews carry the net on the port side astern and circle to the right when fishing, and Italian crews pile the net on the starboard side and circle to the left. One wing is at the bottom of the pile, the bag is in the middle, and the other wing is on top. The cork line is piled forward, the lead line is along the edge of the pile that is nearest the center line of the boat, and the rings lie to the side of the lead line. The purse line is coiled in a shallow bin just forward of the net and has one end running through the rings and fastened to the uppermost end of the net, which is called the skiff end. A couple of small kegs or buoys are tied also to the skiff end. A skiff lies on the clear bit of deck alongside the net.

The trip to the previously determined fishing grounds is made at full speed. On the way the men busy themselves making "chum," or



FIG. 37. Salting and repiling a mackerel ring net after a day's fishing. Photograph by author, Terminal Island, December, 1931.



FIG. 38. Making chum from whole mackerel in a power-driven "hamburger machine" or meat grinder. Photograph by D. H. Fry, Jr., Terminal Island, August, 1929.

"hamburger" as it is sometimes called. Chum is finely ground fish that is thrown into the water to attract the mackerel to the boat. Usually some of the mackerel caught the day before are used in its manufacture. A meat grinder, with specially designed blades driven by a chain connected to the boat's engine, grinds the fish which are placed into the hopper. (See Fig. 38.) The ground-up mass falls into boxes and tubs and is ready for use. In cold weather, chum will remain usable for a couple of days, especially when covered with salt. During the summer, chum more than a day old should be discarded, but some fishermen persist in using spoiled chum which adversely affects the keeping qualities of the fish

that eat it and which are subsequently caught. If the boat has not caught any fish during the last few days and the captain has not been able to procure fish from other boats, it is necessary to wait until the fishing grounds are reached when a few mackerel can be caught on hand lines and ground up.¹⁶ Once in awhile mackerel can be netted without the use of chum but the fishermen usually throw some in to be sure of a catch even though the fish may be very numerous.

The fishing grounds are reached about daylight. The boat now cruises at a somewhat reduced rate of speed. The skiff, with 2 or 3 boxes of chum in it, is put overboard and towed astern. The captain and sometimes one or two other men watch for fish from atop the wheelhouse, some of the crew are at the bow, and often one man ascends the rigging. Various signs betray the presence of a school of fish—the mackerel themselves breaking water which they often do at dawn;

¹⁶ During 1928 and the early part of 1929, many ring netters used live bait instead of "hamburger" for chum. The bait consisted of anchovies, young sardines and various other small fishes. The boats carried small lamparas for catching the bait and were equipped with bait tanks on the deck for carrying the small fish alive. The use of live bait necessitated the investment in a bait net and tank, catching it required at least an hour or two of strenuous work before actual mackerel fishing commenced, and the extra net and tank took up space that could have been used otherwise for fish storage. Moreover live bait seemed to be getting more scarce and harder to catch as time went on. Ground chum proved to be fully as effective as live bait, much more convenient to use, and supplanted it entirely as far as net boats were concerned during the fall of 1929. From a standpoint of conservation it is fortunate that the use of live bait was discontinued, as it undoubtedly put a severe strain on the young fish population of our waters.

dark patches of water denoting a body of fish; or flocks of sea birds darting down to devour the small fish driven to the surface by feeding mackerel. When none of these indications is present, the captain trusts to luck or to the intuition that good fishermen possess in choosing a place to fish.

The spot selected, the boat comes to a stop. As the boat slows down, several of the men at the bow throw chum into the water with wooden paddles or with their bare hands. The chum attracts the mackerel if there are any in the vicinity and they soon come to the surface near the boat, paying no attention to it in their eagerness to get the free meal. Some of the fishermen fish with baited hand lines to make sure that there are enough fish to make a haul worth while. If fish take the hook with the proper frequency and many mackerel appear at the surface, the captain decides to set for the school. While the men at the bow continue chumming, one man gets into the skiff, casts off, and rows to the bow of the boat. The rower stands facing the bow of the skiff. Italian rowers use two oars out the sides; Japanese scull with one long-bladed paddle. (See Fig. 39.) The skiff man commences to throw chum into the water, and after he has gotten the fishes' attention the men on the boat cease chumming. While the skiff man chums, the boat backs slowly away from him, leaving him alone with the fish.

As the boat backs away, the chummers at the bow go astern and several of them station themselves beside the net. When 100 or 150 yards away from the skiff, the captain turns the boat and puts it into forward motion. At his signal one of the men throws the kegs, with the end of the net attached, over the stern. The boat, at nearly full speed, circles the skiff and the school of fish while the men at the stern pay out the net. (See Fig. 40.) One man throws off the cork line, another heaves the lead line and a third pays out the rings and purse line. The entire net is laid out in a circle as the boat returns to the kegs. A man with a boat hook brings the kegs aboard and the set is complete. Making the circle takes one to two minutes. The skiff man



FIG. 39. Chumming a school of mackerel from the skiff. The men who had been chumming from the bow of the big boat can be seen going astern as their boat backs away from the skiff preparatory to shooting the net. Photograph by author, off San Pedro, December, 1931.



FIG. 40. Paying out a mackerel ring net as the boat circles the school of fish. The men at the left are paying out the purse line and rings, while those at the right throw the webbing overboard. Photograph by author, December, 1931.



FIG. 41. Hauling in the bag of a mackerel ring net. The wings are already aboard. Note the bunched rings on the pursing block at the stern, the purse lines running forward to the winch, and the buoy keg which can be seen in the lower left corner. The skiff is still inside the circle but is leaving at the left. Photograph by author, December, 1931.

continues feeding the fish so they will not notice the net that surrounds them.

While the kegs are being lifted aboard, one of the men thrusts a pursing davit, consisting of an iron bar bearing two pulleys, into a hole in the railing at the extreme stern. The kegs are untied, and one of the men runs the end of the purse line through one of the stern pulleys, forward through a pulley on the boom, and wraps it loosely around one of the revolving catheads on the winch. Another man runs the opposite or boat end of the purse line through corresponding blocks and around the other cathead. On the smaller boats, one man handles and hauls both ends of the purse line. Everything is now ready for hauling and pursing the net. The two men at the winch haul on their respective ends of the purse line, aided by the power-driven catheads, drawing the rings and consequently the lead line together under the fish. While they haul the line, the remainder of the crew, with the exception of the skiff man, hauls in the wings—half of them pulling each wing. Drawing on the wings pulls the large meshes into narrow slits that are nearly as impassable for the fish as the fine mesh of the bag.

At about the same time that the wings are aboard, the bunched rings are pulled up against the stern-pursing davit. (See Figs. 41 and 42.) A piece of rope is looped around them, and they and the lead line are lifted aboard with the aid of the boom. The pursing davit is pulled out and put aside. There is no way for the fish to escape now except by jumping over the cork line or by tearing the webbing, so the skiff man ceases chumming, runs his skiff out of the circle over the corks, ties it to the boat and comes aboard to help haul in the bag.



FIG. 42. Hauling in a mackerel ring net. Photograph by D. H. Fry, Jr., off San Pedro, July, 1929.



FIG. 43. Three tons of mackerel are in the landing bag alongside the boat. Note how the skiff supports the cork line. Photograph by author, December, 1931.

On the way in, he throws a lot of chum outside the net to hold the interest of the fish that escaped the haul. Many times a second haul can be made in the same place because of this extra chumming and the chum that has drifted out of the net.

The entire crew is now required to pull in the fine-meshed bag that comes through the water somewhat harder than the coarse-meshed wings. The seine is piled in two heaps just as it comes over the sides with the corks forward and the lead line and rings at the extreme stern. (See Fig. 41.) All but the heavy landing bag, in which the fish are finally concentrated, is brought aboard before the crew ceases hauling. The skiff man returns to his craft and works his way

back to the landing bag. With his help the bunt is brought around opposite the hatch. To prevent the fish from pulling the cork line under by sounding, several feet of the cork line are brought aboard the skiff. (See Fig. 43.) Completing the haul from the time the kegs are dropped requires 25 minutes or more, depending upon how many fish have been impounded.

With the fish confined to the bunt alongside the boat, brailing or loading the fish aboard the boat commences. First a piece of canvas is thrown over the webbing where it lies across the rail. The canvas protects the seine from being worn by the chaffing of the brailing net. The brailer is a hoop net with a 5- to 15-foot wooden handle. The hoop is 2½ to 4 feet in diameter and the bag is 3 to 6 feet deep. The bottom is closed by a purse string that can be slacked to release the fish when desired. The hoop is hung by 2- or 3-point suspension from a line on the boom. (See Fig. 45.) The handle is given to the man in the skiff. He pushes the hoop into the mass of fish until the net is nearly full. At his signal the winch man lifts the brailer and swings it over the open hatch. A third man helps guide it and a fourth releases the purse string, which action causes the fish to drop into the hold. The skiff man retrieves the dip net by means of a rope tied to the handle. When the hold is full, the fish are dumped on the deck. In the case of a boat that has no hold all the fish are carried on the deck. Sideboards along the railing keep the fish in place.

As soon as the bunt is emptied the fishermen haul it aboard and commence repiling the net. The boat end of the net is in place as it was hauled but the other half must be repiled on top of it. The purse line is recoiled and strung through the rings anew. In less than ten minutes after the last fish is aboard everything is ready for the next set. If weather conditions are favorable little more than an hour elapses from the time the net is shot until the boat is cruising for another school. More than an hour is required if the catch runs over 8 or 10 tons, however, as it takes longer to drag that many fish up to the boat and to brail them out of the net.

The above description of the use of the ring net applies to daylight fishing which is the most common method by which mackerel are taken for San Pedro canneries. However, a number of boats, mostly those manned by Italians, have been doing some of their fishing at night time since September, 1930.

Mackerel are located at night by the luminescence given off by the many minute organisms they disturb in their movements through the water. Fishermen become expert at telling what species of fish is making the "fire" and seldom set for the wrong fish. The luminescence can be seen only on the darkest nights, hence no fishing is done on nights when the moon is bright. Mackerel seem to run in larger, denser schools at night, so it is seldom necessary to resort to chumming. Once the look-out locates a school the net is shot and pursed as rapidly as possible. Instead of throwing a keg overboard with the net, night fishermen let the skiff loose as a buoy. A light is placed in the skiff to aid the captain in locating it after circling. While the net is being pursed the fish would have an excellent chance to escape under the boat through the space between the two ends of the seine if some means were not employed to scare them back towards the bag. In daylight fishing the chum keeps the mackerel occupied in the center of the circle so they seldom make a break for liberty until it is too late. Night fishermen use various types of "scares" to keep the fish from escaping under the boat. The simplest scare is rocks thrown into the water.



FIG. 44. Making ready to brail the mackerel aboard the boat. Photograph by M. J. Lindner, near Catalina Island, March, 1930.



FIG. 45. Brailing mackerel from the landing bag. Note the tub of chum in the skiff. Photograph by author, December, 1931.

Planks, paddles or pieces of canvas jerked around on the ends of weighted ropes are all effective as they make the same sort of "fire" that large predacious fish do. The latest and most popular type of scare consists of a powerful electric light, fitted with a watertight socket, which is lowered to a depth of 20 or 25 fathoms and blinked on and off. Not only do the flickering rays keep the fish away from the boat but they often serve to discourage them from sounding. From the time the seine is pursued there is no difference from the daytime methods in handling net or fish.

There is no direct evidence that either daylight or night fishing is

more effective than the other. Although mackerel are said to move in larger schools at night and all record catches so far reported have been made at night, the daylight boats average just about as well over a period of time. It is difficult to make direct comparisons because both types of fishing are seldom carried on at the same time and when they are, one type of fishermen—Italian—is fishing nights and another—Japanese—is fishing during the daytime. Either the time difference or the racial difference would be enough to invalidate the results of a comparison. In general, the Japanese fishermen do far better when fishing with chum in the daylight and the Italians seem to do a little better at night. It must be remembered that because of full moon periods, night fishing must be suspended for one week out of every four and that in addition most fishermen prefer to sleep at night and do their fishing when the sun shines. For those two reasons as much as any others, most of the fishing is done during the day. The canneries prefer their fishermen to make their catches at night, however, as will be seen later in this report (p. 89).

Construction and Operation of the Purse Seine

The net known as the purse seine is a massive encircling net made of cotton webbing that has been soaked in hot coal tar as a preservative measure to protect it from fish slime. It is built as a rectangular piece of uniform-sized mesh with a row of corks at the top to float it at the surface and a rope weighted with lead at the bottom to make it hang

vertically in the water. A rope running through a series of rings along the lead line acts as the pursing device.

There is no purse seine built specially for mackerel fishing. Most of the purse seiners that fish for mackerel do so only occasionally. They use their barracuda nets in the summer and their sardine nets in the winter for catching mackerel. The purse seine is used only by purse seine type boats.

The sardine purse seines that have been used for mackerel range in length from 200 to 250 fathoms and in depth from 20 to 26 fathoms. The main body of the net consists of $1\frac{1}{4}$ - to $1\frac{1}{2}$ -inch mesh (stretched measure), with a narrow strip of heavy 4- or 5-inch mesh selvage all around the edges. A small area near one end of the seine is often made of heavier twine. This is called the bunt or landing bag. At the conclusion of a haul the fish are concentrated in the bunt, preparatory to being loaded into the boat. The cork line is strung with disk-shaped corks, 6 inches in diameter and 2 inches thick, spaced 12 to 20 to the fathom. Ropes extend down both ends of the net from the top to the lower corners. On the up and down lines, as these ropes are called, there are several 2-inch iron rings with a brail line running through them from the bottom to the upper corner. The lead line is strung with 4-ounce lead sinkers spaced very close and totaling about a ton for the entire net. Galvanized iron purse rings, 5 or 6 inches in diameter, are fastened along the entire lead line by means of bridle lines. These lines of light rope are each about 16 feet long and are tied at both ends to points $15\frac{1}{2}$ feet apart on the lead line. The ring is made fast to the middle of the bridle line so it hangs about 2 feet below the net. The individual bridle lines are spaced about 15 feet apart. A rope made fast to one upper corner of the seine runs through all the purse rings, except those on the up and down lines, to be fastened to the other upper corner. This is the purse line, which when pulled tight draws the bottom of the net together to prevent the escape of the fish by sounding.

The barracuda purse seines that are sometimes used in mackerel fishing range from 200 to 230 fathoms in length and 18 to 26 fathoms in depth. The mesh is usually $2\frac{1}{2}$ inches, stretched measure, and the selvage mesh is usually 5 inches.

The purse seine is carried at the stern of the boat on a revolving platform known as the turntable. The seine is paid out and hauled in over a roller on one side of the turntable. The roller can be connected to the engine and turned by power to facilitate hauling. The net is piled with all the corks on one side at right angles to the roller and with the lead line and purse line opposite them.

Purse seiners locate mackerel in the same manner as ring netters. They usually fish at night and therefore do not have to chum the mackerel. The net is circled in the same way with the skiff acting as the buoy. When the circle is completed the skiff end of the net is picked up and the end of the lead line is brought aboard by means of the brail line. The roller is turned toward the side of the boat nearest the circle before hauling commences, as a purse seine is hauled over the side instead of the stern. The purse line is pulled in with the power winch until all the rings are concentrated and the bottom of the net is

closed. A sling is wrapped around the bridle lines, and with the aid of the boom, rings and lead line are lifted aboard. The heavy net is then hauled in over the power roller, both by hand and with the aid of the boom if the load is very large. As the landing bag is at the skiff end of the seine the entire crew concentrates on hauling in the opposite end. The skiff helps support the cork line as the fish are concentrated in the diminishing area of the seine. As the men haul the net, they pile it on the turntable ready for the next haul. When the fish are alongside the boat in the landing bag, brailing commences as in ring net fishing.

A purse seine can be circled in $1\frac{1}{2}$ or 2 minutes and pursed in about 10. Hauling requires one to several hours, depending on the number of fish in the net and on the weather. Whereas 6 or 8 or even more ring net hauls can be made in one day or night, allowing the ring netter to set for several small schools to fill his boat, the purse seiner in order to make any profits must wait until he finds a large school before circling as he can make many less hauls in an equal period of time. Large schools of mackerel are not common, so many times purse seiners return to port empty. The lack of speed of the purse seine discourages most sardine and barracuda purse seine fishermen from using their nets on mackerel, and this lack of effectiveness plus the greater cost—about twice that of a ring net—deter the regular mackerel fishermen from purchasing the heavy turntable seine.

Hook and Line Fishing, 1928-1930

Hook and line fishing is no longer a factor in the canned mackerel industry. Before the price paid to the fishermen dropped in 1930, many small hook and line boats made deliveries to the canneries. Their combined catches amounted to about 6 per cent of the total cannery receipts in 1929. They were for the most part boats fishing regularly for the fresh fish markets. On days when they were able to catch more than the markets wanted they could sell the excess for a fair profit, and on days when the markets wanted no mackerel they could fish for the canneries exclusively. In addition, many former albacore jig boats that otherwise would have laid idle due to the failure of the albacore runs went mackerel fishing during the boom years of 1928 and 1929. The deliveries of the hook-and-liners were small, averaging less than 1000 pounds per trip but at $1\frac{1}{2}$ cents per pound, the one- or two-man crews were able to make a little money. Since the price dropped to half a cent per pound in September, 1930, practically no hook and line boats have fished for the canneries.¹⁷ The small catches they are able to make would not pay expenses at such a low price.

In 1928, net boats entered the mackerel fishery in answer to the urgings of the canners who needed more fish than the hook and line boats could supply alone. In 1930, the line boats just as suddenly dropped out of the fishery because the lowered price offered for fish reduced their income to below the cost of operation. The net boats first supplemented the line boats, then surpassed them, and finally

¹⁷ During November and December, 1930, a specialty cannery took delivery of small amounts of mackerel from 13 hook and line boats, for which it paid a relatively high price.

supplanted them entirely. The shift from one from of gear to the other was due to economic factors only, not to a change in the habits or availability of the fish.

Most of the hook and line craft were jig boats that fished with set lines in the same manner as for the markets. (See pp. 45-50.) They generally set out more lines, however, as their catches were not limited by the comparatively small demands of the markets.

Some of the small boats and a number of larger ones employed a different method of fishing known as striker fishing. San Diego and Newport boats still fish with strikers to a large extent and a few San Pedro boats fish mackerel for the markets in that manner.

The boats are known as live bait boats because they are generally equipped with bait tanks for carrying small fish such as sardines and anchovies, which are used as chum. (See Fig. 46.) The bait boats are manned by crews of 3 to 5 men and carry small lamparas for catching the bait. Some of the bait boats used from 1928 to 1930 were large enough to carry ring nets, but the owners evidently could not afford or did not care to invest in them and so fished with the lines and bait nets they already had for albacore and skipjack fishing. Ground fish, usually sardines or mackerel, was used as chum on the smallest boats, which were manned by 2 or 3 men.

Striker fishermen use a bamboo pole, 8 to 10 feet long, with about 3 feet of line and an artificial lure with a barbless hook. The line consists of about $1\frac{1}{2}$ feet of cotton cord with an equal length of wire fastened to the striker. The jig has a tin head to which are attached white feathers sheathed by fish skin. (See Fig. 47.)

The mackerel are attracted to the boat by the chum which is thrown into the water. After a few minutes of chumming, the boat is surrounded by a swarm of excited mackerel eager to get in on the free



FIG. 46. San Pedro live bait boat. This is a Japanese ring net type boat with the net replaced by bait tanks and poles. Live bait boats of this type were formerly a factor in the cannery mackerel fishery at San Pedro and San Diego. Photograph by author.

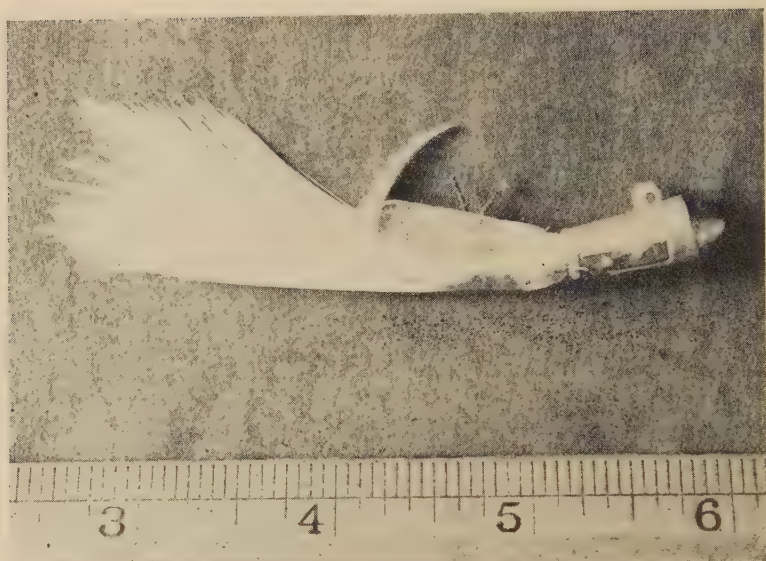


FIG. 47. Feather jig (actual size) with barbless hook used for commercial mackerel fishing with short pole lines. Feather jigs used by sport fishermen are similar except that the hook is barbed. Photograph by author.

meal. The feather jig is cast among them and given a few jerks by the fisherman. The mackerel in their excitement evidently mistake it for food and strike at it, often to be hooked. The instant the fisherman feels a strike he swings the end of the pole straight up over his head, lifting the fish into the air. At the moment the fish is over the deck, the man slacks the line. The fish falls off the barbless hook and the striker goes back into the water with a minimum loss of time. Some fishermen become so expert at striker fishing that they make every motion with the regularity of clockwork. It is reputed that a good fisherman can catch a thousand pounds of mackerel in an hour if plenty of fish are hitting the jig. Chum is thrown into the water all during the fishing in order to keep the mackerel in a state of frenzy. As most of the boats lack holds, the fish are piled on the deck.

Unloading at the Canneries

Unloading methods are the same for all types of boats. The boat to be unloaded is tied to the cannery wharf with the hatch opposite the entrance to the conveyor that carries the fish into the building. The conveyor may be either a belt that carries the mackerel under the wharf to the ground floor of the cannery or it may be a hoist that lifts them to a weigh-house on a tower, whence they are flushed down a flume to tanks in the building.

A hose is passed into the hold or the deckload, as the case may be, and the fish are flooded. The same brailer that is used for transferring the mackerel from the net to the boat is thrust into the mass of fish, lifted to a position above the entrance to the conveyor, and emptied.

(See Fig. 48.) The water sluices more fish into the vacant space just created and before long the fish have been loosened sufficiently so that unloading can be carried on at a high rate of speed. The crews of hook and line boats and a few very small ring netters unload with short-handled scoop nets instead of with the power brailer. (See Fig. 8.)

Comparative Success of Different Forms of Gear

There can be no doubt that nets are more successful than lines for large scale mackerel fishing. All available data show that net boats make consistently larger catches than hook and line boats. The results of comparisons made for the summer of 1929 and the fall of 1930 are presented in Table 5 and Figure 49. During the former period, 104 hook and line boats made a total of 1133 deliveries averaging 957 pounds each, while 77 net boats made 2506 deliveries averaging 6569 pounds. The difference would have been even greater if the canneries had not imposed rather low boat limits that kept the net boats from bringing in really large catches when fish were abundant. The limits were always too high to affect the line boats. The gap between the two types of gear was much wider in 1930, when 13 hook and line boats averaged but 462 pounds per delivery to be completely outclassed by the 28 net boats which averaged 18,289 pounds per trip. The principal reason that the net boats made larger catches in 1930 than in 1929 was that the canneries had fewer boats and consequently higher boat limits. The overwhelming superiority of the net boats is proved conclusively by those two comparisons.

Although the net boats make much larger catches and hence larger gross profits, it must be remembered that they cost



FIG. 48. Italian ring netter unloading at a Terminal Island cannery. Purse seine type boats with ring nets can be seen in the background. The boat is unloading into a belt conveyor beneath the wharf. The winch houses with hoist conveyors that are sometimes used, are in the background. Photograph by author, October, 1930.

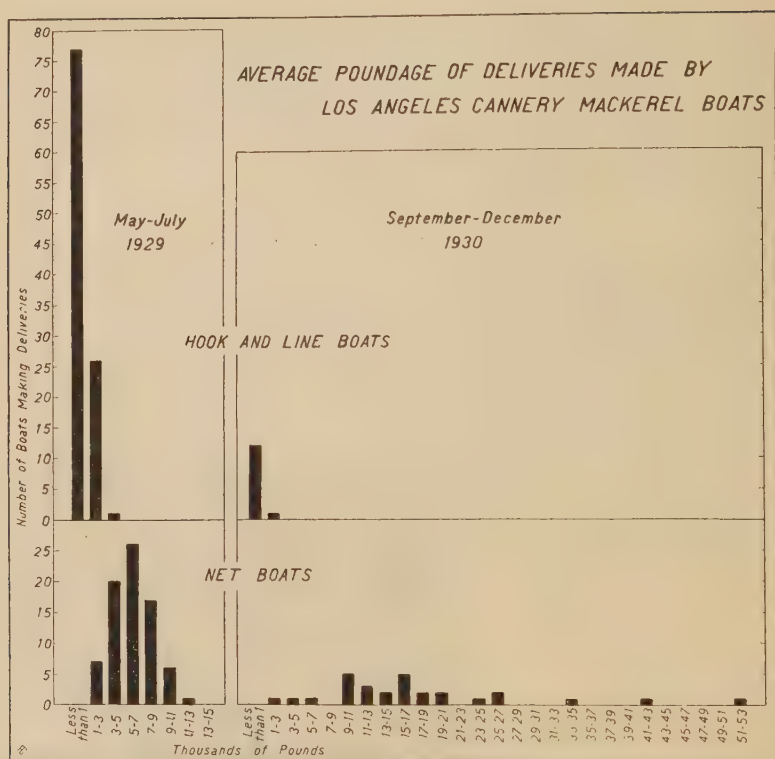


FIG. 49. Average size of the loads of all mackerel boats fishing for San Pedro canneries, May to July, 1929, and September to December, 1930. The bars indicate the number of boats, the deliveries of which equal (average) each amount given on horizontal scale. Hook and line boats compared to net boats.

more to run, their nets represent large investments (\$1,500 to \$4,000), and that their profits are shared by larger crews. Bearing these factors in mind, it can be seen that the line boats were not total failures in the fishery. Their profits were never large enough, however, to warrant daily fishing and most of them delivered mackerel to the canneries only when nothing better offered itself. Every time the fresh fish markets wanted extra quantities of mackerel or whenever the higher priced albacore, barracuda or skipjack could be caught, nearly all the hook and line boats deserted the mackerel canneries. Table 5 and Figure 50 show that the line fishery was a casual one, represented by many boats each making a few deliveries. Most of the set line boats averaged less than three cannery fares per month, but a few of the live bait boats fished rather regularly when the barracuda and skipjack were not running.

The competition between the two types of nets—purse seine and ring net—has been keen, but the ring net has proved to be more successful. The lampara turned out to be ineffective for large scale mackerel fishing and practically passed out of the picture in 1928, although one or two small boats continued to use it until the middle of 1929. Ring net boats showed to better advantage than purse seiners

during both the periods referred to above (Table 5), although during 1930 there was not enough purse seine fishing to prove anything one way or another. The purse seine is perhaps more effective when the mackerel are running in large schools, as several record hauls of 30 to 50 tons each in 1931 tend to show, but as pointed out before, the length of time required to haul the purse seine makes it almost useless for the ordinarily small schools of mackerel. The many times that purse seiners come in empty would bring their average catches down considerably if they could be shown in the table. The higher cost of the purse seine (\$4,000 to \$5,000 as against \$1,500 to \$2,000) must also be taken into consideration in any comparison.

TABLE 5

Comparative Success of Various Types of Boats Fishing for San Pedro Mackerel Canneries

	Hook and line boats	Purse seine boats using purse seine	Purse seine boats using ring net	Small boats using ring net	All boats
May, June and July, 1929					
Number of boats.....	104	16	8	53	181
Pounds of mackerel.....	1,083,968	960,196	2,453,843	13,047,742	17,545,749
Average pounds per boat.....	10,423	60,012	306,730	246,184	96,938
Number of deliveries.....	1,133	156	281	2,069	3,639
Average number of deliveries per boat.....	10.90	9.75	35.10	39.00	20.10
Average pounds per delivery.....	957	6,155	8,732	6,306	4,822
September 25 to December 15, 1930					
Number of boats.....	13	1	8	19	41
Pounds of mackerel.....	24,963	1,880	3,090,519	2,394,330	5,511,692
Average pounds per boat.....	1,920	1,880	386,315	126,017	134,432
Number of deliveries.....	54	1	119	180	354
Average number of deliveries per boat.....	4.2	1.0	14.9	9.5	8.6
Average pounds per delivery.....	462	1,880	25,971	13,302	15,570

The two most important types of boats are the small ring netters and the purse seine boats that use ring nets. Of the two, the purse seine boat has proved to be the most successful and the small boat the most popular. Table 5 shows that the larger boats deliver heavier fares but that there are more small boats fishing. The greater success of the purse seine type of boat is due to its larger capacity, its increased cruising range and seaworthiness, and the fact that the canneries sometimes set higher limits for the larger boats. Occasional loads of 30 tons or more when limits are lifted increase their average catch. More smaller boats are used because there are more of them available. Most of the large boats go sardine fishing in the winter because the high sardine limits favor them, and go barracuda or tuna fishing in the summer because longer trips than the small boats can make are necessary. That leaves a large number of small craft anxious to fish for mackerel rather than lie idle, so the canneries take them on and keep them even when the larger boats are available. The smaller crews and lower operating costs of the small boats are factors that tend to overcome the handicap of lighter loads.

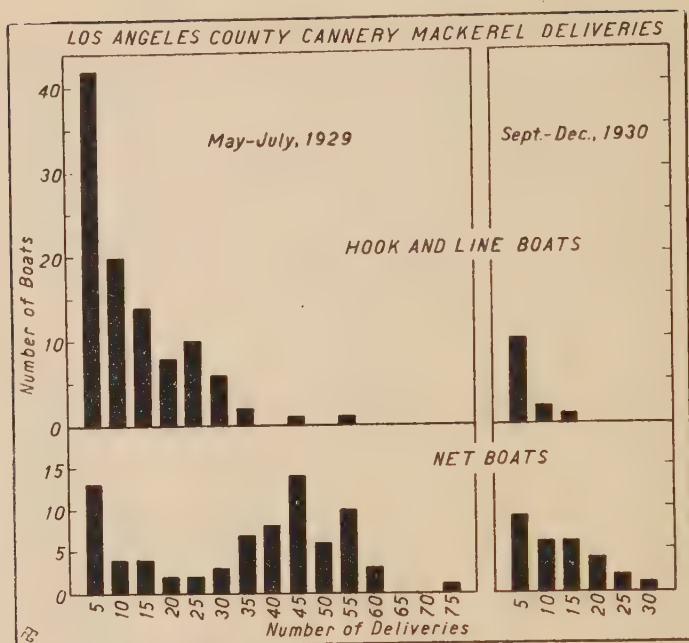


FIG. 50. Number of deliveries made to San Pedro canneries by all mackerel boats during the periods May to July, 1929, and September to December, 1930. Bars indicate number of boats making each number of landings. Hook and line boats compared to net boats.

Summary

The highlights of the preceding section can be reviewed as follows. The mackerel canneries of Los Angeles Harbor are the most important in the State, their pack being not only larger than that of all other districts combined but sufficient to make mackerel canning the third most important fish canning industry of California. The decline in the price of canned mackerel from about \$4.25 per case to \$2.50 resulted in a cut to the fishermen from \$30 per ton delivered, to \$10. There is no definite season for mackerel canning. The fishing grounds are all near the canneries so long trips are not necessary. Net boats, because of their greater efficiency in large scale fishing, control the fishing although hook and line boats were formerly a factor. Most of the fishermen are Japanese or Italian. The boats are of three types: purse seiners, 53 to 80 feet long; Japanese ring netters, 41 to 60 feet long; and Italian ring netters, 35 to 47 feet in length. The boats are powered by diesel or gasoline engines. The ring net, a light weight, high speed, pursed encircling net, dominates the fishery. The heavier purse seine is used by some boats although it is not generally as successful. Fishing is carried on both at night and in the day time.

Salted and Smoked Mackerel

Several San Pedro fresh fish markets and one cannery put up salted mackerel as a side line. When the markets buy more mackerel

than they can dispose of, the fish cleaners salt down the excess in anticipation of future orders. Horse mackerel is also salted at several markets. The cannery packs salted mackerel to special order. The regular ring net mackerel boats supply the fish, as salting is done only when the plant is canning mackerel.

Complete statistics on the salted mackerel pack are not kept so it is impossible to say how much is produced. The output is considerable, however, even if not comparable to the canned mackerel pack. The method of preparing salted mackerel is described on pages 119-120.

A smokehouse in Long Beach produces kippered mackerel on a wholesale scale. The fish used at this plant are shipped in by truck from Newport. (See p. 91.)

On several of the pleasure fishing wharves along the Los Angeles County coast, there are one or more stalls where smoked mackerel can be purchased. The operators of these markets prepare the fish themselves in their own smokehouses. The local pleasure fishing boats and barges supply the smokers with mackerel to some extent. The fish that have been left behind by the anglers who have caught more than they could use, are either sold or given to the smokehouse operators by the owners of the boats. However, some smokers prefer the mackerel caught by regular commercial fishermen as they are generally handled more carefully and are consequently in better condition. The towns where mackerel are smoked for retail sale are Hermosa Beach, Redondo Beach and Long Beach. The methods by which smoked mackerel are prepared are described on pages 121-122.

Size and Condition of Mackerel Sold to Markets and Canneries

Size of Cannery Mackerel

Any fisherman knows that he stands a better chance of selling his catch for a good price if the fish are fresh and in good shape. It is to his advantage to deliver them consistently in good condition. Moreover, markets and canneries alike are more apt to accept large fish than small ones. Large mackerel keep better, are easier to clean, and their bones are less troublesome to the consumer, hence the wholesale markets prefer them to the small ones. Cannerymen claim that small mackerel, less than 13 inches in total length, cost them about twice as much to pack as an equal weight of larger ones. Both canneries and markets often pay less for small fish.

A number of factors influence the size and quality of the mackerel delivered by the fishermen. The type of gear and boat, the length of time the boat is away from port, refrigeration facilities aboard the boat, the place where the catch is made, the season, and the individual fisherman are some of the points that determine the size and quality of the fish.

When it became evident that the mackerel was destined to be one of California's most important fishes, the Bureau of Commercial Fisheries of the California Division of Fish and Game, through its Laboratory, commenced a study of the life history of this species with the idea of determining how much fishing it could stand without being depleted. A study of sizes was selected as one of the lines

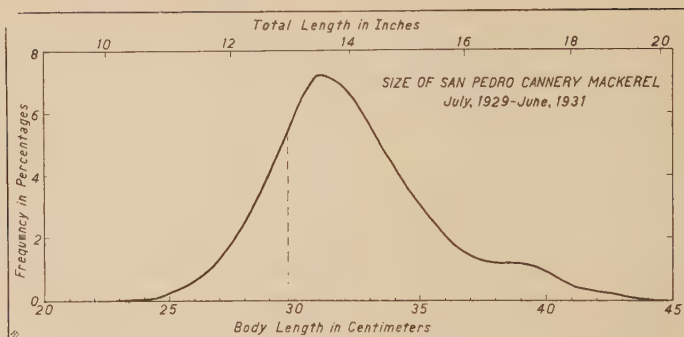


FIG. 51. Size of all mackerel sampled at San Pedro canneries, July, 1929 to June, 1931, inclusive. Number of fish at each half-centimeter expressed as a percentage of total number—21,400 fish of both sexes. Vertical line at 13 inches, the minimum size limit sometimes set by canneries.

of approach. A knowledge of the size of the fish comprising the commercial catch is essential in determining whether depletion through overfishing is taking place. One of the indications of depletion is a drop in size, indicating that the fish do not survive long enough to attain full length. In order to protect young fish until they are old enough to spawn and assure perpetuation of their kind, it is necessary to know the size and age of the youngest spawners. Although this type of research requires a long time to bring about definite results as far as possibilities of depletion go, several other interesting and important facts are brought to light in the meantime.

As a basis for size studies, the Laboratory took semiweekly samples of the Los Angeles Harbor cannery catch from July, 1929 to September, 1930, during the times when mackerel were being delivered. Since September, 1930, samples have been taken three times a week when possible. Each sample is composed of 200 fish, taken at random from the day's catch of several boats. Fishermen making deliveries are questioned so that data on locality of catch, type of gear and fishing effort may be gathered. A special measuring board, divided into half-centimeter units, is used for getting the lengths. The distance from tip of snout to fork of tail is considered the length of the fish. From time to time, numbers of mackerel are weighed in order that weight-length problems may be undertaken. At the time the sample is taken, other studies are made, but the length and weight of the mackerel are all that need to be discussed here.

The frequency curve based on all the mackerel measured at San Pedro canneries between July, 1929 and June, 1931, inclusive, is presented in Figure 51. The extreme size range of cannery mackerel is from 20 to 45 cm. (9 to 20 inches, total length). The average length was 32 cm., the most desirable size for canning. It can be seen at a glance that the greatest number of fish fell within the limited range between 28 and 35 cm. Approximately 80 per cent were longer than 29.5 cm., the length corresponding to the canners' occasional minimum size limit of 13 inches, total length. It is possible that if size limits were never in effect there would be a greater percentage of smaller fish,

but as it stands one-fifth of the fish delivered are smaller than the canners want.

For packing in the standard 1-pound tall can, average sized mackerel are cut transversely three times; one cut removes the head, the next divides the body into two parts, and the third severs the tail fin. The second cut is made behind the anal opening, so the anterior piece is the larger. (See Fig. 61.) The large pieces are put in the can first and the shorter, more slender pieces are used to fill the vacant spaces. In fairly large fish the second piece is so large that it can be used the same as the anterior piece or can be cut again to make two smaller filler pieces. However, extremely large fish, those over 39 or 40 cm., are not desirable because they are so stout that the pieces must be trimmed down, resulting in a loss of both time and fish. On the other hand, a very short fish yields but one piece large enough to be worth while. It takes so many more small fish to fill a given number of cans that the extra work done by the butchers in cutting them and by the packers in putting the small pieces into the cans makes them less economical to pack.

Not only do small mackerel furnish a smaller number of full length pieces, but the pieces are much more slender. The weight of mackerel increases with growth at a rate considerably in excess of the cube of the length. A fish twice as long as another weighs a little over ten times as much. As a difference of but a few inches in length corresponds to a difference of a pound in weight, it can be seen that what appear to be minor fluctuations in length can be of considerable importance to the canneryman.

Gear as a Factor Determining Size

Almost as soon as net fishing for mackerel commenced, it could be seen that the nets were taking smaller fish than the set lines that had previously been the major form of gear. Although the canners never had to warn the hook and line fishermen, they have found it necessary to penalize ring netters from time to time for bringing in small mackerel.

It is possible for the fishermen to tell whether a school contains a majority of either large or small fish but there are bound to be some small ones in every school. It is a temptation to set for a large school, even if it is composed of small individuals because the canneries usually take undersized fish after an argument. The most effective measure to prevent delivery of small fish is to pay less for them consistently, a scheme resorted to by several canneries. Under those conditions the fishermen are not apt to waste time on profitless fish.

Although hook and line fish appeared offhand to be larger than net fish on an average, it was thought best to make a careful comparison for verification.

Comparative data were available for two seasons of fishing—the fall of 1929 and the spring of 1930. Since then there has not been enough hook and line fishing to provide material for study.

The results of the autumn comparisons have been plotted as length frequency curves in Figure 52 (Part A). The curves for both types of fishing are bimodal, with the corresponding modes almost identical!

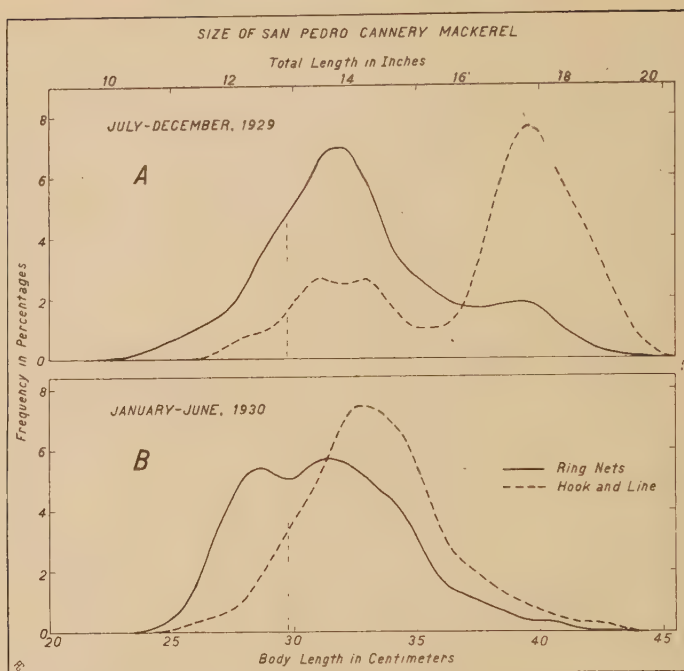


FIG. 52. A: Comparison of sizes of San Pedro cannery mackerel taken by hook and line and by ring nets during the fall months of 1929. Number of fish at each half-centimeter expressed as a percentage of the total number of fish in each curve. Vertical line at 13 inches, total length, the minimum size limit sometimes set by certain canneries.

B: Comparison of sizes of San Pedro cannery mackerel taken by hook and line and by ring nets during the spring months of 1930.

located. Both types of gear took toll of two different populations composed of large and small fish respectively. However, the lines took relatively greater numbers of the large fish and less of the small ones, whereas the reverse was true of the nets. During the fall fishery of 1929, then, hook and line boats caught larger fish on the whole than net boats. In fact, many of the line fish were too large from the canneries' standpoint. The high percentage of undersized fish delivered by the net boats and the large proportion of overly large mackerel that the line boats caught tended to balance each other so that the catch of one type of boat was little more desirable than that of the other.

The comparison for the spring fishery (see Fig. 52, Part B) presents a different situation. The large fish of the previous fall are almost totally absent from the catches of either type of boat. Nevertheless, the line fish average larger. The net curve shows more small fish and less large ones than the other, although the extreme size range is practically the same. The difference between the curves is slight but it must be remembered that really important weight differences arise from minor length deviations. During the spring of 1930, it can be said that line-caught fish were more desirable to the canners as far as size goes.

More data are necessary before definite conclusions about gear differences depending on seasons can be reached, but enough material has been presented to prove that hook and line boats do take larger fish than net boats. Several explanations for this fact can be advanced but none of them is entirely satisfactory and most of them are unsupported by adequate proof.

The size of the gear is undoubtedly an important factor regulating selection of fish by size. The mesh of the ring nets is small enough to retain all but the tiniest mackerel; any fish over 6 inches long is apt to be caught if it is within the circle. On the other hand, the large hooks used by the set-liners exclude many of the smaller fish—those that find it easier to tear the bait from the hook than to swallow it whole.

From observations made by fishermen and the writer, it appears that the largest mackerel in a school are usually the most aggressive and that they bully the small ones and drive them away from the bait to be caught themselves. Although not proved beyond all doubt, this action of the large mackerel is extremely likely. If correct, the "bullying" theory would account in large measure for the fact that the proportions of large and small fish are different in the catches made by the two types of gear although all sizes appear in both.

An unproven theory advanced by some fishermen is that the larger fish live in the kelp near where the lines are set and that the small fish inhabit the open waters where the nets are circled. Another theory, that was not borne out by a careful study, would have us believe that small fish always run in the large schools that netters usually set for, and that the small schools most often supplying the hook and line boats are composed of large fish.

Nets always fish at the same depth regardless of the season or any other factor, whereas set lines can be lowered or raised to give the best results. The nets, then, can take only those fish that are within about 15 fathoms of the surface, while the lines can catch fish at much greater depths. It is quite possible that most of the largest mackerel are usually below the reach of the nets but are available to the set lines. It may be that they vary their depths with the season. By glancing at Figure 52, we see that there were relatively more large fish in the autumn, 1929, samples than in those of the spring of 1930. Assuming that the samples were representative, we gather that there were more large fish available to the lines and to some extent to the nets during the fall. We may then presume that in the fall, the large fish are relatively near the surface but that they go down beyond even the lines in the spring. The fact that it is known that the hook and line boats fished somewhat nearer the surface during the spring of 1930 than the previous fall and caught less large fish, suggests that it is necessary to go down to get the big ones. The depth theory, however, can not account for the fact that pole line boats, fishing within a few feet of the surface, take larger fish than net boats. The bullying habits of the large fish and the selective action of the big hooks must suffice as explanations.

In the meantime no further data can be gathered because there are no longer any hook and line boats fishing for the canneries. The catches delivered to the fresh fish markets can not be used for a comparison

because the market fishermen select and land only their largest fish, cutting the others for bait or throwing them away before reaching port.

Different Methods of Fishing the Same Gear

With a considerable difference apparent in the sizes of mackerel caught by net and by hook, another problem of comparative sizes arose. In the fall of 1930, a new method of catching mackerel with ring nets came into widespread use, namely, fishing at night instead of during daylight hours. As described in another part of this report, daylight fishermen locate the fish by the presence of sea birds, by a ruffling of the ocean surface, or by dark patches in the water. After locating the fish, they commence chumming to attract and concentrate the mackerel and then circle them. The men who fish at night locate the fish by means of luminescence and circle without chumming. The mackerel undoubtedly act differently during hours of darkness than in daylight. For one thing, according to the fishermen, they run in larger, denser schools at night. A comparison of the sizes of the hauls made by day and night boats shows that night hauls are nearly always larger. If the large, dense schools are composed of either smaller or larger fish, a comparison of the sizes of day- and night-caught fish would possibly reflect that difference. Assuming that mackerel school according to size, it is possible that schools composed of large fish feed near the surface in the daytime and go down below the range of nets at night, or the reverse may be true. It may be that fish of a certain size are more susceptible to chumming than other sizes.

Regardless of the reasons underlying any difference in size, a proof of that difference or lack thereof would not only be an interesting addition to the lore of the mackerel and its fishery but would enable the canners to contract with the fishermen who fish in the manner resulting in the largest mackerel. On the whole, Japanese fishermen are best at daylight fishing, whereas the Italians probably do better when fishing at night.

Enough samples of both day and night fish were taken during the fall of 1930 to form the basis for a comparison. Three studies were made—one for fish caught in October, one for November, and a final one embodying all the data from September 24 to December 1, 1930.

The frequency curves based on the October data, 1400 fish of each sort, were startling to say the least. (See Fig. 53, Part A.) They showed that night-caught fish were consistently larger than those caught during the daytime. The mode of the night-fish curve is 2 cm. higher than the day curve. The night-caught fish averaged 33 cm. in body length and the daylight fish averaged 32 cm. Twelve per cent of the night-caught fish were less than 30 cm. long (less than 13 inches, total length) as against 24 per cent of the daylight fish. Undoubtedly the schools encountered at night during October contained larger fish, that is, the schools from which samples were taken, as chance may have played a part in choosing samples of larger fish.

The curves for November, including 600 fish of each kind, gave results almost exactly the reverse of the October curves. (See Fig. 53, Part B.) The curve for daylight fish has its mode 1.5 cm. higher than that of the night-caught fish. The average length of daylight fish was 31.6 cm., whereas for night fish it was 31.2 cm. Of the daylight

fish, 20 per cent were less than 30 cm. long, whereas 30 per cent of the night fish were below the cannery's limit. A study of the November curve alone would lead one to believe that night-caught fish tend to be smaller than day-caught fish. The November curve includes fish sampled on December 1 (caught during the night of November 30), comprising the last sample taken in 1930.

The data comprising the two foregoing comparisons were combined, and the 400 night-caught fish sampled during the last week of September were added to make a final study. The resulting frequency curves, which embody 2000 daylight fish and 2400 night fish, are presented in Figure 53, Part C. It can be seen that there is no really significant difference between the fish caught during the hours of darkness or daylight. For the whole period, night-caught fish averaged 32.0 cm. and the daylight fish 31.9 cm., a difference well within the bounds of chance. The percentages below 30 cm. were 23.1 for daylight fish and 23.9 for night fish, the difference again being small enough to be disregarded. It must be remembered that less fish entered into the November samples when daylight fish averaged larger so that perhaps a greater number of fish sampled then would have further neutralized the effect of the large night fish of October.

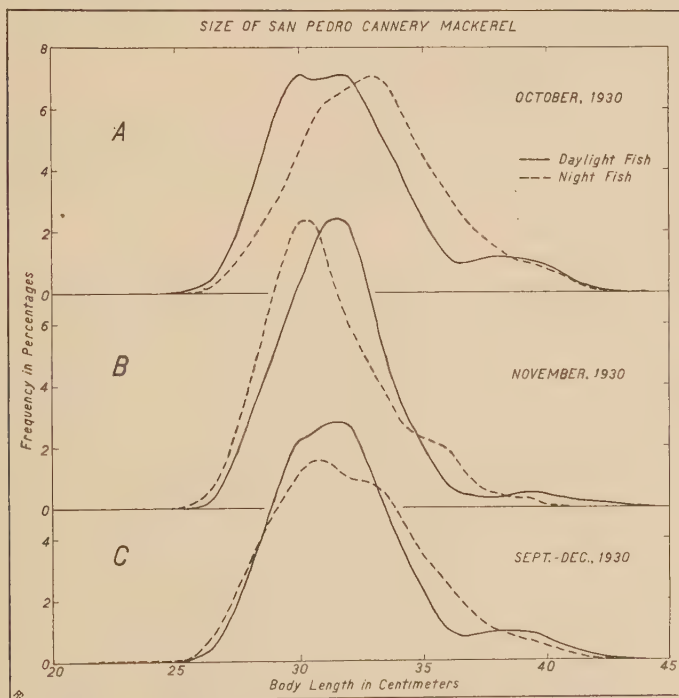


FIG. 53. Comparison of sizes of San Pedro cannery mackerel taken by daylight fishing and by night fishing, using ring nets in both cases. Number of fish at each half-centimeter expressed as a percentage of the total number of fish in each curve.

A: Mackerel sampled during October, 1930.

B: Mackerel sampled during November, 1930.

C: Summary of A and B including fish sampled in September, 1930.

After studying all three curves and comparing the average lengths, we would hesitate to make any statements to the effect that large fish were more readily available than small ones either at night or in the day. Any differences in sizes seem to be due to individual boats chancing upon schools containing a preponderance of small, large or medium sized fish regardless of the time of day or night. In addition, the similarity of the curves indicates that all the sizes caught at night can be taken in the daylight, and vice versa. Until more data can be gathered, it can not be concluded that there is more size selection in one type of fishing than in the other.

Quality of Mackerel Delivered to Markets and Canneries

Two facts must be borne in mind during a discussion of the condition of the mackerel delivered to canneries and markets—the flesh of the mackerel decomposes rapidly after death unless given the best of care, and the better the fish the higher the price. Mackerel must be delivered fresh for either cannery or fresh fish market use. If partially decomposed fish is packed in cans, harmful gases are often generated which swell the can and moreover the soft pieces of flesh break up and present a distasteful appearance when the can is opened. Wholesale fish markets ship fresh mackerel great distances—as far as Denver, Colorado, and Salt Lake City, Utah. Fish that is already on the way to spoiling when it is landed would never stand the long trip to retail markets even if heavily iced.

It is essential that markets and canneries take care of their fish immediately after delivery, the former to ice and ship them, the latter to pack them without delay. The best of care on their part, however, will not make good fish out of the poor ones that are sometimes delivered by careless fishermen.

The old superstition that the rays of the moon poison the flesh of mackerel is not based on facts, but it is well known that the rays of the sun beating down on mackerel cause the fish to spoil very quickly. Some fishermen bring their mackerel in on the deck uncovered. This practice has nothing to recommend it and should be discouraged. The top layer of fish becomes dried and soft and the others become warm. If the boat has no hold, deckloads should be covered with damp burlap.

As nearly all the California mackerel boats fish close to the home port and deliver their fares within a few hours of catching the fish, it is scarcely necessary for them to carry ice. Undoubtedly ice would be an aid in keeping the fish in good condition, but the price paid for mackerel is too low to warrant the extra cost. The boats that fish in Mexican waters and deliver Spanish mackerel must necessarily carry ice to bring the fish safely through the long, hot trip home.

Practically all of the mackerel delivered to the fresh fish markets are caught by hook and line boats, because these boats can bring in better fish consistently. For one thing, their fish are larger. Their loads are smaller so more care can be given the fish. In the large loads carried in the holds of net boats, the smaller fish near the bottom of the load are often bruised badly by the weight of the others above. When a mackerel is bruised, its flesh decomposes rapidly. The entrapped fish milling about in the landing bag of the net injure each other, the brailing net dipped into the bag bruises the fish, and dropping the fish

into the hold and brailing them out again bruise them further. The fish are in good enough shape for immediate canning but would spoil before reaching a retail market. Moreover, one large ring net load would flood the market for days, and price and quality would drop.

Besides the manner of handling the catch, the method of making the catch has a bearing on the quality of the fish delivered. Net fish are treated more roughly than line fish while being caught, although they are usually put directly into the hold whereas line fish are left on deck while others are being caught. Trammel nets and gill nets set for other fish sometimes enmesh mackerel, but as the fishermen using those forms of gear are after higher priced fish they do not take the trouble to handle the mackerel carefully and those they do bring in are usually crushed and bruised. On the whole, hook and line caught fish arrive in better shape than net fish, but all net fish are not of the same quality.

Although there seems to be no size difference between daylight and night-caught ring net fish, there is a difference in their condition when landed. Night-caught fish are usually in better shape for two reasons. In the first place, the night fishermen make their hauls during the coolest time of the twenty-four hours and deliver their fish early in the morning before the heat of the sun can soften them. The daylight fishermen make their hauls between sunrise and sunset, usually in the morning. Their fish are aboard during the heat of the day and can not be kept as cool. Perhaps the most important thing to take into consideration is the use of chum by daylight fishermen. The chum consists of ground-up mackerel at least a day old and often two or three days old. It is often rancid when the greedy mackerel swallow it. The immense amounts the fish eat and the rough handling they receive cause their stomachs to burst and the ill-smelling "hamburger" is distributed throughout the body cavity, tainting the flesh of the mackerel. Chummed fish are invariably softer upon arrival and spoil more rapidly. In addition, the canneries have to pay for the chum as it can not be separated from the fish during weighing. When live bait is used as chum, the effects are not so bad.

The locations where catches are made do not seem to have any effect on the quality of the mackerel except that fish caught at a distance from port are not as fresh when delivered as those caught closer. However, one canneryman at least has claimed that mackerel taken in the vicinity of the whale factory ship which operated (1929) near San Clemente Island were unfit for canning because they fed on stale whale meat. The fish were large and fat but the flesh was soft and rancid, according to him.

The mackerel of the highest quality are those delivered to the canneries from September to February, inclusive. Not only are the fish firmer but the weather is generally cool enough to allow a maximum of handling with a minimum of spoilage. During the spring and early summer the mackerel are full of soft roe or milt which is not only excess weight for which the canneries have to pay but a condition lending itself to ready spoilage. Spawning takes place from May to July, inclusive. During the summer the fish are usually soft when delivered, due to the hot weather. The catches of the hook and line market fishermen are not affected much by seasonal conditions because the fishermen

can take extra precautions with their small loads when the fish are a bit soft.

When a load of mackerel contains an appreciable percentage of other species, the cannery loses out by having to pay for the entire load and getting the use of only a part. The other species, with the exception of horse mackerel which are canned with mackerel, are thrown into the fertilizer plant with the offal or are extracted and taken home by the workers, neither means of disposal resulting in a profit to the canner who paid for them. However, it is impossible to avoid catching other fish that are schooled with the mackerel and impractical to attempt sorting them out either before or at the time of delivery. Night hauls generally contain a few sardines; the percentage is often quite high in the winter. Daylight hauls invariably contain a few bonito and often jack smelt and kingfish. Horse mackerel are sometimes present in large numbers; occasionally as much as 40 per cent of the catch is composed of them. In the spring large numbers of worthless blacksmith and an occasional barracuda can be found in the mackerel catch. Hauls made close to kelp beds are apt to contain a greater proportion of miscellaneous undesirable species than those made in open water. Offshore hauls, however, are more apt to contain sardines. All the species of fish noted by the writer in three years' observation of the San Pedro cannery mackerel catch are listed below.

<i>Occurrence</i>	<i>Common name</i>	<i>Scientific name</i>
Very numerous-----	Horse mackerel	<i>Trachurus symmetricus</i>
Very numerous-----	Bonito	<i>Sarda chiliensis</i>
Very numerous-----	Sardine	<i>Sardina caerulea</i>
Numerous-----	Jack smelt	<i>Atherinopsis californiensis</i>
Numerous-----	Kingfish	<i>Genyonemus lineatus</i>
Numerous-----	Barracuda	<i>Sphyræna argentea</i>
Numerous at times-----	Blacksmith	<i>Chromis punctipinnis</i>
Numerous at times-----	Queenfish	<i>Seriplus politus</i>
Few-----	California flying fish	<i>Cypselurus californicus</i>
Few-----	Japanese herring	<i>Etrumeus micropus</i>
Few-----	Sand dab	<i>Orthopsetta sordida</i>
Few-----	Kelp fish	<i>Oxyjulis californicus</i>
Few-----	California halibut	<i>Paralichthys californicus</i>
Few-----	Green-tail perch	<i>Phanerodon atripes</i>
Few-----	White perch	<i>Phanerodon furcatus</i>
Few-----	Midshipman	<i>Porichthys notatus</i>
Rare-----	Shad	<i>Alosa sapidissima</i>
Rare-----	Opal-eye	<i>Girella nigricans</i>
Rare-----	Skipjack	<i>Katsuwonus pelamis</i>
Rare-----	Halfmoon	<i>Medialuna californiensis</i>
Rare-----	California pompano	<i>Palometa simillima</i>
Rare-----	Kelp bass	<i>Paralabrax clathratus</i>
Rare-----	Sharp-ridged turbot	<i>Pleuronichthys verticalis</i>
Rare-----	Spotfin croaker	<i>Roncador stearnsi</i>
Rare-----	Sculpin	<i>Scorpaena guttata</i>
Rare-----	Lizard fish	<i>Synodus lucioceps</i>
Rare-----	Bluefin tuna	<i>Thunnus thynnus</i>

Summary

Canners and markets alike want large, fresh fish in preference to others. The extreme size range of the mackerel delivered to San Pedro canneries is 9 to 20 inches, total length. Both hook and line boats and ring net boats catch all sizes of mackerel but the line boats get relatively more large fish and less small ones. This selectivity is probably

due to the size of the hooks and the aggressiveness of the large fish. Ring nets take the same sized mackerel when fishing either at night or in the day. Locality of catch has no effect on size or condition of fish. Hook and line boats generally deliver their fish in better condition than net boats. Fish caught at night and delivered in the morning are in the best condition. Winter mackerel, on the whole, arrive at the canneries in better condition than summer mackerel. Horse mackerel, bonito and sardines, in the order named, are the most numerous extraneous fishes in the cannery mackerel catch.

ORANGE COUNTY

Extent of the Fishery

Newport Beach, the only fishing town of any importance in Orange County, is one of the leading mackerel ports of California. The Newport mackerel fishery is very similar to that of San Pedro as far as fishing methods go, and the fish enter the same markets to a large extent. Not only is there considerable interchange of boats between San Pedro and Newport but San Pedro boats regularly fish off the Orange County coast on the same grounds as the local boats.

The Newport mackerel catch was negligible until 1923, during which year the deliveries rose to nearly 100,000 pounds. The following year 200,000 pounds were landed. Similar advances were recorded for other species of fish at this time. The increases were due to the growth in population in Orange County and to the extensive improvements made in Newport Harbor. The fresh fish mackerel catch has remained at about the 200,000-pound level since 1924. Scarcely any horse mackerel are recorded as landed in Orange County.

In 1928 the Newport mackerel catch experienced a rise comparable to that of the Los Angeles and San Diego fisheries. (See Fig. 9.) The million pounds above the fresh market deliveries were shipped by truck to the canneries at Los Angeles and Long Beach harbors. The Newport fishing grounds are approximately 25 miles from the canneries, an 8-hour round trip for the small Newport fishing boats. An enterprising Newport resident, J. M. Cooper, came to the conclusion that the Newport fishermen would prefer to land their fish at their home port, within five miles of the fishing grounds, for a somewhat reduced price (\$25 instead of \$30 per ton) rather than make the long daily trip to San Pedro, which would eat up all their profits and keep them away from home. The fishermen agreed and went mackerel fishing for him. Cooper hauled the mackerel by truck to the canneries and sold them for the standard price of \$30 per ton. Other operators followed his example and the trucking continued until the canneries cut down on mackerel packing toward the end of 1929. Approximately 3,500,000 pounds of mackerel and relatively small amounts of bonito were trucked during 1929. The smokehouse in Long Beach is still supplied with Newport mackerel by truck. The Newport fishermen seem to catch large, fat mackerel and handle them carefully, so some of the canneries and smokehouses prefer them to San Pedro-caught fish. Moreover, the convenience of truck-load quantities arriving on schedule is an advantage not to be overlooked by the packers.

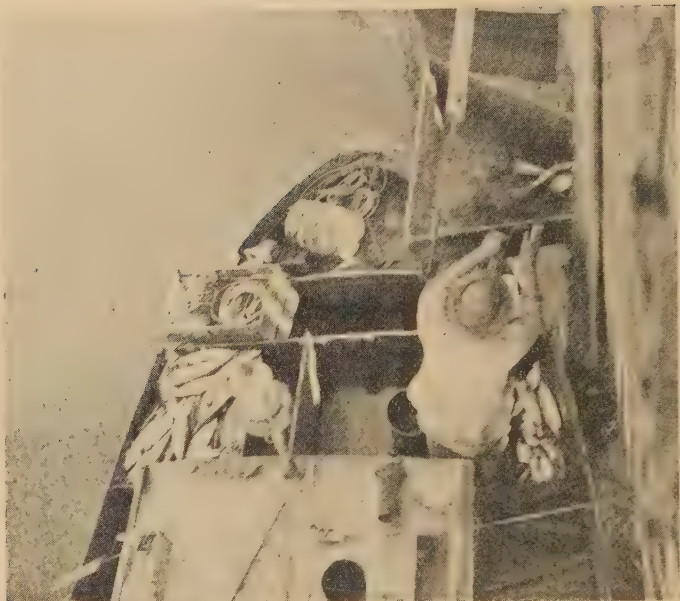


FIG. 54. Unloading a Newport mackerel boat. The fisherman is throwing the fish by hand into a hoist conveyor. Note the coiled line and the keg buoy. Photograph by D. H. Fry, Jr., January, 1931.

From time to time in 1930, a cannery operated at Newport, packing considerable quantities of mackerel.

Several small smokehouses at Newport produce smoked mackerel that is sold locally.

Fishing Methods

The Newport mackerel fleet is composed entirely of hook and line craft. Many of the boats are of the conventional Monterey-San Pedro jig boat type. Some are larger, being similar to those formerly used for albacore fishing. A number of the boats are former pleasure launches of all types, ranging from dilapidated runabouts to antique cabin cruisers. A few San Pedro ring net boats fished for the cannery when it operated in 1930. The Newport fishermen are of all nationalities with Scandinavians predominating.

In the summer most of the fishermen fish with bamboo poles, using live bait or strikers in the same manner as at San Pedro. (See pp. 74-76.) During the winter the mackerel are said to descend to depths beyond reach of the short pole lines and the fishermen use set lines similar to those used by San Pedro jig boat fishermen. (See pp. 45-50.)

The boats deliver their loads to the several receiving wharves in the inner harbor. Belt conveyors lift the fish to waiting trucks. The markets are not on the water front, so all fish destined for either local or distant markets or the Los Angeles County canneries must be hauled by truck. The Newport cannery is situated on the bay and can take direct delivery.

The Newport Beach Open-Air Market

On any pleasant day, summer or winter, a novel scene can be encountered on the ocean beach at Newport. There can be seen a dozen or two umbrella-covered dories and skiffs drawn up on the sand and surrounded by a crowd of people. This group of boats comprises the popular "producer to you direct" fish market unique to Newport.

A number of dory fishermen operate out of Newport. They make their catches of mackerel, rockfish, barracuda, sablefish, bonito, and other species with hook and line a short distance off Newport and bring them ashore to sell direct to the consumer. Considerable quantities of fish are sold in this fashion.

Some of the boats are fitted up with elaborate showcases, beside which the fishermen's wives stand and call their wares. The mackerel sell here for 8 to 10 cents per pound, cleaned. At several of the boats higher on the beach, locally smoked mackerel, bonito and barracuda can be purchased. The smoked fish dories, as well as a few of the others, never leave shore but take the fares of seagoing boats.

Although direct sales by fishermen are common throughout the State, at no other place in California is there a regular market place for carrying on the business.

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V. THE SAN DIEGO MACKEREL FISHERY

EXTENT OF THE FISHERY

During the years leading up to 1928, San Diego—the only port south of Newport where mackerel are caught commercially—was the third most important point of delivery in the California mackerel fishery. The fishery was distinctly one to supply the fresh fish markets which annually took delivery of 300,000 to 500,000 pounds of mackerel. The catch showed a gradual increase up to and including 1927. (See Fig. 9.)

Previous to 1927, with the exception of a 13,000-case pack in 1917, there was practically no mackerel canning done at San Diego. During 1927, four tuna canneries started experimenting on mackerel packing. Early in 1928 one of them commenced operations on a fairly large scale, to be followed in November by another. The San Diego mackerel fishery had ceased to be an exclusive market fishery and San Diego jumped to second place in California landings. In 1929 the mackerel catch exceeded 9,000,000 pounds as several canneries packed fish in quantities. The 1930 pack was very light, however, and San Diego dropped back to fourth place. Very little mackerel was canned in 1931.

One or two of the canneries carry on dry-salting operations as a side line and occasionally dry mackerel and Spanish mackerel. In former years dry-salting was of considerable importance at San Diego but lately a poor market for their products has caused the operators to curtail their activities. During the winter of 1930–1931 a small saltery put up some salted mackerel and herring.

Very few horse mackerel are caught at San Diego. The few that do appear in the catches of the mackerel boats are either entered as mackerel by the dealer or are thrown in with the Pacific mackerel in compiling the catch statistics, so it is impossible to determine what percentage of the mackerel catch is composed of horse mackerel.

THE FRESH MACKEREL FISHERY

The wholesale fish dealers are located in a building near the water front at the foot of Broadway in San Diego. The unloading wharf is across the street near the Municipal Pier.

The market for fresh mackerel at San Diego, although never too good, is remarkably steady. It is best when there is a scarcity of the better known and higher priced yellowtail, barracuda and the fishes from Mexican waters. The usual price paid to the fishermen for round fish is 2 cents a pound when delivered in small loads. During periods of fish scarcity, the price is sometimes raised to 4 cents as an inducement to greater fishing effort. When other fish are plentiful the markets profess to despise mackerel and offer ridiculously low prices or even no price at all. All too often the fisherman has to give in and dispose of his catch for the proverbial song.

Mackerel seem to be available at San Diego throughout the year. Few are caught during the late summer, however, because other and higher priced fish are comparatively abundant then so that neither the markets nor the fishermen care to bother much about mackerel. The winter is the season of the heaviest fresh mackerel deliveries. (See Fig. 55.)

All the mackerel delivered to San Diego fresh fish markets are caught on hook and line. The fishing grounds are just outside the Silver Gate from La Jolla to a little south of Coronado.

Most of the boats are similar to the Monterey-San Pedro jig boats, 25 to 35 feet long. They carry crews of one to three men. The fishermen are principally Japanese, Portuguese and Italian.

The jig boats fish with set lines which are similar to those in use at San Pedro. Instead of being kept in square boxes when not in use the lines are coiled in shallow circular baskets about 1½ feet in diameter with the hooks around the edge and the line in the center. The fishermen haul their lines in over a roller or pulley at the side of the boat, a practice followed by very few San Pedro fishermen. Figure 56 shows a jig boat lying at the wharf with the fisherman recoiling a line in a basket, the pulley over which the line is hauled aboard, and a load of mackerel on the deck. Other species of fish most often taken accidentally on the set lines are sharks, smelt and sheepshead.

The live bait boats fishing for barracuda and yellowtail during the summer often catch mackerel. At times they bring some ashore and sell them. These boats fish either with short poles and strikers as described for San Pedro (pp. 74-76) or with hand lines and hooks baited with small live fish. Rockfish boats occasionally land small amounts of mackerel that have been caught on their set lines.

The boats unload at the wharf near the foot of Broadway. When ready to unload, the boat ties up under a cargo hoist operated by men from the market. They lower enough fish boxes to hold all the mackerel

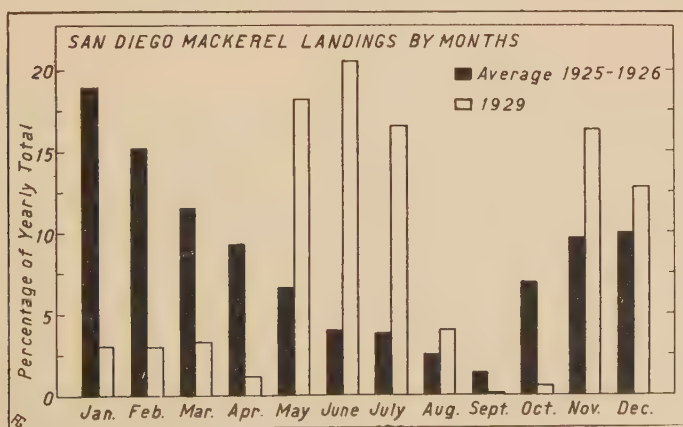


FIG. 55. San Diego mackerel landings by months. Black bars represent the averages of 1925 and 1926 to show the seasonal trend of fresh mackerel landings; white bars represent 1929 to show how mackerel canning disrupted the normal fresh fish seasons. Percentages were used to make figures comparable.



FIG. 56. San Diego mackerel fisherman re-coiling his line while waiting to unload. Note the block over which the line is hauled. Photograph by D. H. Fry, Jr., December, 1930.

they wish to buy. The fishermen fill the boxes and the marketmen haul them up with the winch. The boxes are weighed, put on push carts and taken to the market across the street. Sometimes the larger boats with cargoes of more expensive fish crowd the little jig boats away from the hoists. When that happens, the mackerel fishermen must throw their fish one at a time to the wharf above.

The mackerel taken by the salteries are provided by the boats fishing for the fresh fish markets. Fishing methods of the cannery boats are described in the following section.

THE CANNED MACKEREL INDUSTRY

General

The history of mackerel canning at San Diego is like that of the San Pedro industry on a smaller scale. Practically no mackerel was packed prior to 1928, with the exception of a war-time flurry of activity in 1917. The production for 1928 was 25,000 cases, followed by an output of 86,000 cases in 1929. The slump in 1930 was relatively worse than at San Pedro as production dropped to 4000 cases. (See Table 3.)

The six fish canneries on San Diego Bay are arranged along the water front in three groups, as follows: two in the Point Loma district near the entrance to the bay, two in the factory area north of the Municipal Wharf, and a pair in the southern industrial district.

When the canneries started large scale operations on mackerel, the season for that fish became rather irregular. (See Fig. 55.) Few canneries operated prior to May, 1929, so the landings for the early months of that year were relatively light. During the early summer the canneries operated full blast, but with the beginning of the skip-jack and yellowtail season in August neither the packers nor the fisher-

men cared to take the lower priced mackerel any more. At the conclusion of the skipjack-yellowtail season toward the end of October, the fishermen commenced taking mackerel again. In all likelihood any mackerel canning at San Diego in the future will take place only when no other kinds of fish are obtainable and hence the mackerel seasons will not be constant. Mackerel are available throughout the year and can be had whenever the canners feel like packing them.

Jig Boats in the Cannery Mackerel Fishery

When the tuna and sardine canneries added mackerel to their production list, it was only natural that the set line boats delivering mackerel to the fresh fish markets should turn to them as an outlet for their larger catches even though they paid lower prices.¹⁸ The little jig boats fished in the same manner as before, but because of the better demand for their fish they could go out more often and could be sure of disposing of larger loads. Many of these boats, however, fished for the canneries only at irregular times. During 1929, some 28 jig boats each made more than 20 deliveries of mackerel to the canneries whereas about twice as many more made less frequent landings.

Live Bait Boats

Another type of boat that figured prominently in the cannery mackerel fishery is the live bait boat.

In general, San Diego fishing methods can be listed as follows: traps for lobsters, gill nets for herring, encircling nets (lamparas and ring nets) for sardines and bait, set lines for mackerel and rockfish, and short hand lines or pole lines for everything else. There is a large fleet of live bait boats equipped for fishing with the short lines for albacore, barracuda, skipjack, tuna, and yellowtail—all of which are species that are found in nearby waters during the summer and fall only. Until mackerel canning commenced in 1928 most of the live bait boats lay idle during the off-season, although a few replaced their bait tanks with nets and fished for sardines, and a few journeyed to Mexican waters to catch whatever they could. With the increased demand for mackerel, the otherwise idle boats were enabled to go mackerel fishing. No new gear was necessary because mackerel can be caught by the same methods of live bait fishing as the species the fishermen were accustomed to catching. The fishing methods are similar to those described for San Pedro. (See pp. 74-76.) During 1929, about 30 live bait boats made occasional deliveries of mackerel to the canneries and about 20 others fished regularly for mackerel.

These boats range in length from 35 to 60 feet and most of them are built along the same lines as the Japanese boats at San Pedro. (See Fig. 46.) They carry crews of three or more men, usually Japanese or Italian, with some Portuguese, Scandinavians and others.

Occasionally some of the bait boats go out with only the captain and perhaps one other aboard and fish for mackerel with set lines like jig boats.

¹⁸ The usual cannery price for mackerel in 1929 was \$25 per ton and sometimes as low as \$20 for net-caught fish.

Lampara and Ring Net Boats

Net boats did not so nearly supersede the hook and line boats for cannery fishing as they did at San Pedro. Nevertheless there was considerable net fishing for mackerel in 1929.

Some of the San Diego live bait boats remove their bait tanks in the winter and fish for sardines with either lamparas or ring nets. Eleven of the boats that did so in 1929 also fished for mackerel with their sardine nets. For the most part these boats followed the same procedure: They fished for mackerel as well as sardines with nets during the early part of the year; they continued using the nets for mackerel after the sardine season ended; changed to hook and line fishing in the summer, catching mackerel as well as other fish; and returned to the use of nets for catching mackerel toward the end of the year just before sardine canning started. The season for "pound-oval sardines" (so called because of the size and shape of the tins in which they are packed) includes the months of January, February and March. Fishing for the tiny "quarter-oil sardines" (young fish packed in oil in quarter-pound cans) is carried on from January to June, and for "half-pound sardines" during the fall. Most of the sardine boats have two nets, one for bait and for the quarter- and half-pound sardines, and a larger one for the "pound-ovals." It is the latter net that is used for mackerel fishing.

Prior to the 1929-1930 season, both the bait and "pound-oval" nets were lamparas or round haul nets. During 1929, the ring net as used at San Pedro made its appearance in the San Diego sardine fishery. It was used by three boats the first season. Because of the success enjoyed by the users, the ring net will undoubtedly become the standard gear for the large sardines. A few of the Japanese boats used ring nets part of the time for catching mackerel, but most of the converted live bait boats that fished with nets for mackerel in 1929 employed the lamparas that they already had. One large purse seine type tuna boat made a few catches of pound-oval sardines and mackerel with a ring net.

It is at San Diego only that the lampara has been at all important in the mackerel fishery. The ring net had superseded it at San Pedro before the mackerel fishery expanded enough to make net fishing necessary and at no other place have mackerel been taken in any quantities with the lampara.

The lampara is a net designed to encircle and impound schools of fish. It is made of tanned cotton webbing. The upper edge is held at the surface of the water by a light line strung with cork floats and the lower edge is held down by a heavily weighted lead line. The net consists of three parts: two wings of coarse mesh and a central bag of fine mesh. The wings lengthen the net so that a large circle can be made. The lead line of the bag is much shorter than the cork line and the design of the bag is such that part of the webbing forms a "floor" under the fish when the net is circled. As the net is hauled toward the boat, the lead lines of the two wings come together under the fish and the space between the wings is greatly reduced. This closing-in tends to herd the fish into the bag, which by now can be likened to a huge scoop with its open end toward the boat. As soon as the wings

are on board, the open end of the "scoop" is lifted out of the water by hauling the lead line on board. The fish can not escape after that.

The lamparas used at San Diego for mackerel and pound-oval sardines range from about 175 to 200 fathoms long and 40 to 45 fathoms deep in the bag.¹⁹ The mesh in the wings is 5 or 6 inches and in the bags one-half to 1 inch, stretched measure. The bait nets are similar but are usually smaller and lighter in every respect. Five or more men comprise the crew of a San Diego lampara boat; 3 or 4 men can operate a bait net. The Japanese round haul net, which is used by some of the boats, is similar to the lampara except that the bag is deeper and more simple in construction.

The lampara is carried in a pile on the after deck of the boat. The fishermen locate the mackerel in the same manner as San Pedro ring net fishermen. (See p. 66.) When a school has been brought together after chumming, a buoy to which one end of the net has been fastened is cast loose. The boat circles in front of the school at half speed while the men pay out the net. When the buoy is picked up, the boat comes to a stop and the crew divides, pulling in both wings simultaneously. This draws the boat and the scoop together. The use of scares, such as rocks, wooden paddles or poles, is resorted to so that the fish will be frightened back from going under the boat and escaping. When the wings are in, the crew lifts the lead line aboard so that the fish can not escape except by jumping the cork line. After a breathing spell for the men, which is made necessary by the rapid hauling of the wings, the crew hauls aboard all but the small part of the bag in which the fish are concentrated for brailing aboard. Brailing and later unloading at the canneries are conducted as at San Pedro. (See pp. 70, 76.)

Number of Boats Fishing in 1929

A total of 130 boats participated in the San Diego cannery mackerel fishery during the peak year of 1929. Of these, 47 made more than 20 deliveries each for the entire year. (See Fig. 57.) These can be called the regular boats. In this group there were 28 jig boats, ranging

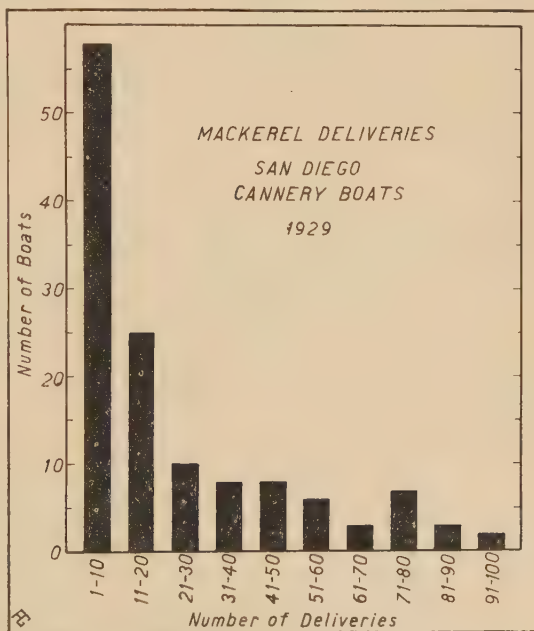


FIG. 57. Number of deliveries made by all mackerel boats fishing for San Diego canneries in 1929. Bars show number of boats making various numbers of landings.

¹⁹ Dimensions of lamparas as given by the fishermen.

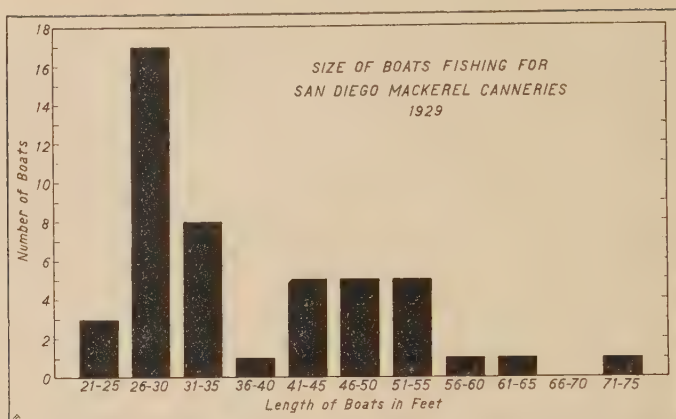


Fig. 58. Lengths of mackerel boats fishing for San Diego canneries during 1929. Bars indicate number of boats in each size range. This graph includes only those boats that made more than twenty deliveries during the year.

from 22 to 35 feet in length. (See Fig. 58.) The live bait boats, ranging from 35 to 65 feet in length, and some of which used lamparas or ring nets part of the time, numbered 19. The 47th was a 73-foot combination bait and ring net boat of the purse seine type. The remainder of the fleet, 58 of which made no more than 10 deliveries and 25 of which landed fish between 11 and 20 times, consisted of all types of craft with jig boats making up over half the total. Some of these boats fished mackerel regularly for the markets and merely took to the canneries what they could not sell to the fresh fish dealers, but most of them concentrated on other fish and caught mackerel on the side.

The fishery, it can be seen, was one of many boats, most of which fished intermittently. Small boats predominated and line-caught fish composed the better share of the total catch. It is impossible to determine what proportion of the total cannery catch was provided by net boats, as practically all the net boats fished part of the time with lines. It would also be impossible to get a good idea of how much of the net catch was caught by ring nets, as several fishermen rebuilt their lamparas into ring nets at various and forgotten (by them) times during the year 1929.

MACKEREL CAUGHT IN MEXICAN WATERS

Although many California boats fish in Mexican waters, none of them ever delivers mackerel or horse mackerel in appreciable quantities. For one thing, mackerel and horse mackerel are abundant enough off the California coast to supply the demand without going to Lower California where other and more expensive fish are numerous. Moreover, during the long trip up from the Mexican fishing grounds, the mackerel would probably spoil or at least become too soft to sell. The Mexican duty discourages the importation of fish that will scarcely bring a price as high as the tax, so the fishermen would lose money by trying to sell Mexican-caught mackerel or horse mackerel.

On the other hand, the boats fishing off the Lower California coast occasionally bring back quantities of Spanish mackerel. The hook and line boats, fishing for cabrilla and other fish, and the barracuda purse seiners make the catches. Deliveries are made at both San Diego and San Pedro.

The general public is not educated to the fine food qualities of this handsome fish so the market is very small. Japanese, Slavonians and Portuguese are the largest consumers. Because of the restricted outlet for sales the price to the fishermen is low. For loads of less than 1000 pounds, the price is generally 8 or 10 cents per pound, round. Larger loads bring as low as 3 or 4 cents a pound while the occasional fares of about 2 tons are not usually salable beyond a ton.

The catches of Spanish mackerel are extremely irregular, being made only when the boats chance upon the fish. There are considerable fluctuations from year to year but the general trend of deliveries has been downward since 1921. (See Fig. 59.) For the 6 years up to and including 1929, the annual catch averaged a little less than 15,000 pounds. Landings were considerably larger in 1930, reaching a total of 36,000 pounds for the year.

SUMMARY

The following facts are worth repeating in summarizing the San Diego mackerel fishery. San Diego is the southernmost mackerel port of California. With annual deliveries of a half million pounds to the fresh fish markets, San Diego is one of the leading mackerel centers of the State. Mackerel canning increased from practically nothing to an important position in 1928 and 1929, only to drop back again in 1930 to a minor rank. Mackerel are available throughout the year but market deliveries are low in the summer when other species are abundant. Jig boats using set lines supply the markets with mackerel. Jig boats, live bait boats, lampara boats, and ring netters all contributed to the cannery catch in 1929. Practically no horse mackerel are caught at San Diego. Very few mackerel or horse mackerel are taken by California boats fishing in Lower California, but considerable numbers of Spanish mackerel are brought in from Mexican waters by these boats and delivered at both San Diego and San Pedro.

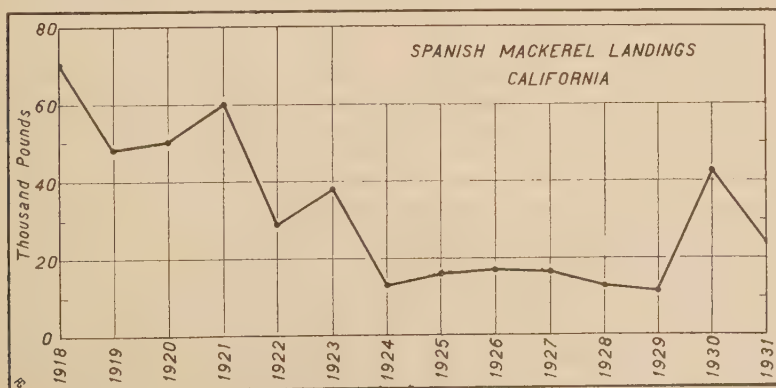


FIG. 59. Yearly deliveries of Spanish mackerel to San Diego and San Pedro made by California boats fishing off the west coast of Lower California, Mexico.

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VI. NUMBER OF MACKEREL BOATS IN THE SEVERAL COUNTIES

Approximately 450 boats participated in the California mackerel fishery during the last six months of 1931. (See Table 6.) Of this number, 69 fished regularly for fresh fish markets, 17 fished consistently for canneries, and 78 were engaged in taking anglers on pleasure fishing trips. The others made occasional landings of mackerel while engaged primarily in other fisheries.

TABLE 6
Number of Mackerel Boats by Counties, July to December, 1931

County	Market boats regular	Market boats occasional	Cannery boats regular	Cannery boats occasional	Pleasure boats	All boats
San Francisco		10			2	12
San Mateo					2	2
Santa Cruz	1	44			4	45
Monterey	41	104		2	6	146
San Luis Obispo		4			4	6
Santa Barbara		1			1	2
Ventura		1			3	4
Los Angeles	19	81	17	17	38	136
Orange	5	42			11	55
San Diego	3	46		1	7	52
Totals, California	69	322	17	20	78	449

The table includes all boats that sold mackerel to wholesale fish dealers or canneries in California and all boats that made a charge for taking out pleasure fishermen who caught mackerel. The so-called "regular" boats are those that made consistent landings of mackerel, *i.e.*, twice a week or more in the cases of the large mackerel ports of Monterey and Los Angeles, and once a week during the season at the other places. The pleasure boats include the anchored barges and the boats that go out on regular schedule, in both cases making a charge for fishing privileges.

The largest number of boats claimed by a single county was Monterey's total of 146. Los Angeles County was a close second with 136. Other leading counties were Orange with 55, San Diego with 52, and Santa Cruz with 45.

Several boats made landings in more than one county, so that the totals by counties, as given in Table 6, do not agree with the grand total of 449. Ten Monterey boats made occasional mackerel deliveries at Santa Cruz during their brief sojourn at that town for the salmon fishing, and one San Diego boat landed some mackerel at San Francisco while fishing for a sardine cannery. These 11 boats each appear in two county totals but count once only in the grand total.

Similarly, the totals for the various counties include boats that appear in two categories, such as fresh fish markets and pleasure boats. Many of the live bait pleasure boats sell to the markets the surplus catches of their patrons. Also, a number of boats fish for both markets and canneries, thus appearing in two columns but counting once only in the total number for their county.

VII. HANDLING, PACKING AND MARKETING MACKEREL

PREVENTION OF SPOILAGE

It is a well-known fact that all fish commence to spoil very soon after death occurs. Immediately after a fish dies it stiffens and the flesh becomes rather firm and elastic. This condition is called rigor mortis. As long as a fish is in the state of rigor mortis it is undeniably fresh because this condition passes away rather rapidly. On the other hand, the absence of rigor mortis does not necessarily mean that the fish is stale or spoiled.

Anderson ²⁰ summarizes the characteristics of stale fish as follows:

1. Rigor mortis has passed off.
2. Reddish discoloration on the ventral aspect of the backbone.
3. Smell becoming tainted, passing to putrid.
4. Flesh strips off readily and cleanly from backbone.
5. Abdominal walls becoming soft and pulpy, with commencing discoloration and tainted odor.
6. Gills lose characteristic tint, becoming gray and slimy.
7. Eyes gray and sunken.

The spoilage of fish is caused by two agencies, autolysis and bacterial decomposition.²¹ Autolysis is the chemical and physical changes which are brought about after death by digestive ferments called enzymes that are contained in the cells of the fish. The blood, certain tissues, and glands such as the kidney contain very active enzymes which are most active under slightly acid conditions at a fairly high temperature. During rigor mortis the acidity of the tissues increases, causing an acceleration of autolytic decomposition. These enzymes are most active in dilute solution and are inactive in the absence of water. Bacteria are unicellular organisms which when placed in suitable media multiply rapidly and produce enzymes which break down animal tissues and the various organic substances contained in organic matter such as the body of a fish. Bacteria are inadvertently introduced into the fish during handling and cleaning operations. They grow most rapidly in a moist medium at temperatures between 25° and 45° C. The lower the temperature the more slowly both autolytic and bacterial decomposition proceed.

It is to prevent or at least retard decomposition that the various means of preserving fish have been evolved. If it were not for the ability of fish packers to render fish immune from spoiling, people living at a distance from the source of supply would be unable to enjoy fish as food. Furthermore, fish are not equally available throughout the year so it is important that the surplus of the flush months be preserved and held over to supply the demand of the lean months.

Certain fishes spoil more readily than others. The mackerel is one of those that spoil most rapidly. In order to bring this fish to market in the best condition it is necessary to use some sort of decomposition deterrent. Practically all the known methods of fish preservation are

²⁰ Anderson's report (1909) as reviewed by Tressler (1923, p. 264).

²¹ Tressler, 1923, p. 308.

applied to the mackerel in California. These methods are in general: salting, freezing or chilling, smoking, and canning. The first three processes were known to primitive man and have not been modified in principle or even in method to any great extent since the Stone Age. Canning is a development of modern science unknown before the nineteenth century.

Practically all fresh fish shipped to inland markets or held any length of time in seaside markets is iced if not actually frozen. The lowering of the temperature simply retards bacterial growth and the action of the autolytic enzymes. Upon becoming warm again after removal from the ice, decomposition sets in again as before icing.

When fish is salted, decomposition is halted in two ways. The increase of alkalinity due to the penetration of salt slows the activity of the autolytic enzymes to the stopping point. Through osmosis,²² salt in solution takes the place of the natural moisture of the fish. Without moisture neither the autolytic enzymes nor the bacterial enzymes can act, so upon the withdrawal of moisture, decomposition comes to a standstill.

As the first step in the process of smoking, fish are salted to some extent so the preserving effects of both smoking and salting are combined in smoked fish. The actual preservative effect of smoking fish is due to the drying out of the flesh, thus inhibiting bacterial growth, and to the action of the very small amounts of wood creosote constituents deposited in the fish by the smoke.

Properly canned fish will not spoil because the agencies causing decomposition have been inhibited by sterilization. Intense heat is the agency by which sterilization is effected. The can, containing cooked or raw fish, is sealed and subjected to a temperature of 230° to 240° F. for an hour or more. The bacteria that cause decomposition thrive at rather high temperatures but a protracted cooking at more than 230° kills them. As long as the can remains sealed no more bacteria can attack the fish. The great advantages of canned fish are that the flavor and appearance are not greatly different from cooked fresh fish and that the product can easily be shipped and kept anywhere in any climate for any length of time.

In the following pages an account is given of the various methods by which California mackerel are prepared for market.

FRESH MACKEREL

Handling

Because mackerel spoil readily it is necessary to handle them with the greatest of care and speed, especially when they are destined for distant markets. Consequently the fish are cleaned and iced immediately upon their delivery to the fish dealer.

At all the California ports where mackerel are landed, the wholesale markets are located on or near the wharves at which the fishing boats discharge their cargoes. It is the universal custom for the fishermen to load the mackerel into boxes on the boats. The boxes are

²² Osmosis can be defined as the diffusion which takes place between two miscible fluids separated by a permeable partition such as the membranes in the fish, and which tends to the equalization of the conditions on the two sides of the membrane.

hoisted onto the wharf by means of power- or hand-operated winches. The marketmen put the boxes on small trucks, wheel them into the market, and weigh them. As soon as possible, the cleaners empty the fish onto a drainboard and commence cleaning them. This operation is quite simple. The belly is slit from the throat back; the intestines, blood, and sometimes the gills are scraped out with the cleaning knife; and the gutted fish are slid down the drainboard into a sink of water. After all the mackerel are cleaned, the sink is drained and the fish are washed with a hose. The cleaned mackerel are placed in a box, cracked ice is shoveled over them, and the box lid is nailed down. The boxes are shipped by truck or train to the point of destination.

As mackerel are available throughout the year and are classed as an inexpensive, small-profit fish, they are seldom held in cold storage or frozen.

Horse mackerel are cleaned and shipped in the same manner as the Pacific mackerel. This species does not seem to bruise and spoil so readily and does not need to be handled with quite as much care.

Marketing Fresh Mackerel

The wholesale fish dealers of Monterey, San Pedro, Newport, and San Diego not only supply the retail markets in their vicinity but the wholesale and retail dealers in other parts of the State.

The markets on the wharf at Monterey sell mackerel direct to the restaurants and retail dealers of Monterey, Santa Cruz, Watsonville, Salinas, and other nearby towns. Most of their fish, however, go direct to the wholesale fish dealers of San Francisco and to a lesser extent to Oakland and Sacramento. In fact some of the fish markets at Monterey are branches of the big San Francisco firms. The San Francisco dealers sell their mackerel to retail stores and restaurants in that city and the rest of the bay region. The Sacramento dealers furnish mackerel to the towns of the Sacramento Valley.

The San Pedro fish markets sell mackerel to the retailers and cafes of the Los Angeles Harbor district and to wholesale firms in Los Angeles, which in turn sell the fish to Los Angeles and suburban retail stores, restaurants and hotels. Some of the San Pedro markets have uptown branches to distribute fish to retailers. In addition, the San Pedro dealers ship direct to retail stores in distant towns although the Los Angeles distributors handle most of the out-of-town business. San Pedro mackerel are sold in all the cities of the San Joaquin Valley, particularly Bakersfield, Fresno and Stockton, and supplement Monterey mackerel at Sacramento and San Francisco. The inland towns of southern California get their mackerel from the Los Angeles wholesalers of San Pedro mackerel. Relatively small quantities of mackerel are shipped to the cities of the Rocky Mountain States from Los Angeles. The beach towns of Los Angeles County are supplied by the markets located on the wharves that can be found along the shores of Santa Monica Bay and at Long Beach.

The mackerel landed at Newport are retailed at Newport and Balboa Beach and sold to the retailers of Santa Ana, Anaheim, Fullerton, and other nearby cities. Quantities are shipped also to wholesalers in Los Angeles.

The markets at the foot of Broadway in San Diego supply mackerel to the restaurants and hotels in San Diego and to the retail stores in that city and the other towns in the extreme southern part of the State.

Los Angeles and San Francisco, the two largest cities in California, are the largest buyers of mackerel. The smaller inland cities not only buy less actually but also less per capita. Nearly all classes and races of people buy mackerel but the foreign populations are the largest consumers. Not only do most of them lack sufficient money to purchase higher priced fish but they are not imbued with the mistaken idea that because a fish is cheap it can not be good. The best sales are made among Mexicans, Japanese and Negroes. The mackerel loses its scales with even the most careful handling, and as Jewish people will not eat scaleless fish, no sales can be made to the large Jewish populations of San Francisco and Los Angeles.

During the winter and in Lent, mackerel sales are at their best. In the summer, sales drop off a little because higher priced, more popular fish are available and in addition difficulty is encountered in keeping the mackerel from spoiling in hot weather. The retail price of mackerel ranges from 10 to 20 cents per pound.

CANNED MACKEREL

Canned mackerel is the most important single product of the California mackerel fishery.

The following description of canning methods applies to the canneries at Los Angeles Harbor. The San Diego, Long Beach, Hueneme, and Monterey canneries employ similar processes. Actual canning methods vary but little at the several canneries but the methods for preparing the fish for canning are somewhat different.

Unloading from Boats

The fish are unloaded from the boats into either a hoist or a belt conveyor, depending upon the cannery.

The bucket hoist conveyor lifts the mackerel to the top of a tower or winch house on the wharf. The fish spill into large buckets in which they are weighed. There are two buckets so that when one is full the stream of fish can be diverted to the other. Each one has a capacity of 500 pounds and is suspended on a spring scale. After recording the weight of the bucketful, the winch house man spills the fish into a flume carrying a strong stream of water which washes the fish into a receiving tank in the cannery. From the tank the fish are flushed through flumes to the cutting machines or butchering tables. A flume leads to each table or machine from the bottom of the tank. A man controls the flow of fish from the tank by opening and closing gates on the flume.

At other canneries the belt conveyors carry the fish into the cannery where they are spilled into dump carts. The carts are pushed onto a platform scale for weighing. The capacity of the carts varies from 500 to 2500 pounds. After weighing, the cart is dumped so the fish spill on the floor. From the floor they are either shoveled directly



FIG. 60. Mackerel cutting machine at a San Pedro cannery. This is the first of three types described in the text. The women are putting the fish into the "cups" that can be seen on the belt. The cut fish drop from the cups and are carried to the cleaning tables by the conveyor at the right. Photograph by D. H. Fry, Jr., and author, August, 1931.

onto the cutting tables or are picked up by another belt conveyor to be lifted into a large wooden tank whence they are distributed to the cutting tables through flumes.

Butchering

The fish should be butchered immediately upon their arrival at the cannery. At present, the longest trip made by the mackerel boats bringing fish to the canneries is under 5 hours except in isolated instances. Allowing time for making several sets and for awaiting their turn to unload, the fishermen deliver their fish within 12 hours of the time of catch. Unless exposed to the rays of the sun or crushed at the bottom of the hold, the fish should be in good condition for canning when delivered. However, the boats often do not arrive until the evening, in which case the mackerel were formerly held over all night in the cannery because of the difficulty in assembling butchering and packing crews in the evening. When it is necessary to hold them, the cannerymen should ice them thoroughly or, better yet, keep them in chilled brine. All too often this was not done in the early days of the new industry. Many times the fish were left on poorly drained concrete floors all night with little or no ice. In hot weather the loss was very high and spoiled fish occasionally got into the cans. The cannerymen soon learned their lesson and fish are no longer held over night.

All other things being equal, a far better pack can be obtained from freshly delivered mackerel than from fish that have been held over night. One way the canners can insure morning deliveries of

mackerel is to persuade their fishermen to fish at night, because when the fishing is done during daylight hours delivery can not be expected before afternoon.

The first steps in preparing the fish for packing are cleaning them and cutting them to the proper size. There are two ways of performing these operations—by machine and by hand. Some canneries use one method, some the other, and some employ both at once when lots of fish are being delivered. A final cleaning by hand always supplements either method.

The machines are similar to those used for cutting sardines except that they are larger because of the greater size of the mackerel. The machines were designed and developed at the canneries so those in use at no two canneries are exactly the same.

All the machines are alike in that they are located near the "fish tanks" where the fish are stored after being unloaded from the boats. Gate-controlled flumes lead from the tank to deep trays on both sides of the machine. The fish are flushed into the trays from which they are transferred by hand to the machine. (See Fig. 60.)

One type of machine functions as follows: Women operators place the fish, belly up, in transverse grooved metal holders or "cups" on a belt conveyor which carries them into the cutter. (See Fig. 60.) The fish are brought into contact with a battery of three revolving disk blades, two of which sever the heads and tails respectively while the middle one divides the bodies transversely. The knife which makes the cross-cut through the body is so placed as to cut right at the insertion of the second dorsal fin of an average sized fish. (See Fig. 61.) The heads and tails fall into a flume or screw-conveyor and are carried to the reduction plant where all the waste parts are utilized in the manufacture of fish meal and fertilizer. As soon as the cross-cuts are made the cup turns automatically so the fish is parallel to the direction of progress. It passes under a revolving blade that slits the belly and a rotary brush that cleans out the greater part of the intestines. At the end of the conveyor where the belt turns back under itself, the pieces of fish drop from the cup onto a belt conveyor which carries them to a table where women remove the remaining viscera and complete the cuts that the machine sometimes misses. The thoroughly cleaned pieces are thrown onto a belt conveyor which carries them to the packing room. Two women can feed this type of machine at the

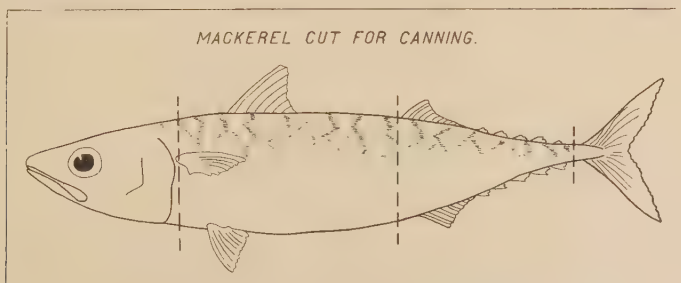


FIG. 61. Sketch of an average sized mackerel, showing the places where cuts are made before canning. The two central pieces are canned; the head and the tail fin are run into the cannery's fertilizer plant.



FIG. 62. Mackerel butchering table at a San Pedro district cannery. Note the pile of fish at the left. Photograph by the author, October, 1931.

rate of 65 to 70 fish per minute or 1 to $1\frac{1}{2}$ tons an hour, depending on the size of the individual fish. This number of fish keeps 6 or 7 women busy doing the final cleaning.

Another type of machine is similar to the first part of the one just described. A battery of three knives makes the cross-cuts as the fish pass under it in the cups. The heads and tails fall into flumes to be carried away. The butts or tail pieces, which contain no viscera and need no further cleaning, fall into another flume to go on to the packing room. The larger pieces drop from the cups onto a belt that extends down the middle of a long table. Workers stationed along the table remove the pieces, slit the belly from end to end and remove all viscera and blood with a knife.

A third type of cutting machine has two conveyors carrying the fish into two batteries of knives. Two women feed each conveyor from a single fish tray. The four women can supply the two conveyors with about 125 fish a minute so that the machine can cut between 3 and 4 tons of fish per hour, depending upon the size of the fish.

There are but two rotary knives in the first battery under which the fish pass. One of these severs the head and the other divides the body into two parts. The heads fall into a flume to be carried away to the reduction plant. The two parts of the body fall onto a belt that passes in front of several women who place the pieces in two conveyors. The butt pieces, still bearing the tail fin, are placed in cups at right angles to the direction of progress. The conveyor carries them under a vertical revolving blade that severs the tails. The women can so place these pieces that very little loss results from severing the tail. The butt pieces drop onto a belt that carries them to the packing room. The anterior segments, still containing the viscera, are put on a narrow belt, belly down and parallel to the direction of the conveyor. They pass over a revolving blade that slits the bellies and a rotary brush that removes most of the intestines. The conveyor deposits the pieces on a cleaning table where women remove by hand the intestines that still

remain. The cleaners place the thoroughly cleaned pieces on a conveyor that leads to the canning room.

At all the cutting machines, all the operators except the engineers in charge are women. The workers performing the finishing operations of cleaning and cutting are also women. Some canneries employ Japanese women almost exclusively. These are usually wives of the cannery's fishermen. At other canneries, mixed crews comprised of Americans, Italians, Mexicans and Japanese are employed.

At the canneries where the butchering is done by hand, a specialized type of cutting table is in use. (See Fig. 62.) A crew of 12 to 16 work at each table. The workers are usually either Filipino men or Japanese women.

The workers are stationed at regular intervals along both sides of the long table which consists of three parts. (See Fig. 63.) The first part is in the form of a shallow trough in which the round fish are dumped, either shoveled from the floor or flushed from the storage tanks. The workers at this section behead the fish, slit them open and remove the larger viscera with their knives. The cutting is done on boards nailed over a flume at the sides of the trough where the fish are dumped. The heads and entrails fall through holes in the boards into the flume, which carries them to the fertilizer plant. The cutters throw the partly cleaned fish to the second section, which consists of a tank of running water. The workmen here use ordinary teaspoons to scrape out the remaining entrails and blood, holding the fish under water. They throw the thoroughly cleaned fish onto the third section of the table. Here skilled cutters armed with large butcher knives place the fish in simple miterboxes and cut the body into two parts and sever the tail. To do this they place the anterior part of the body

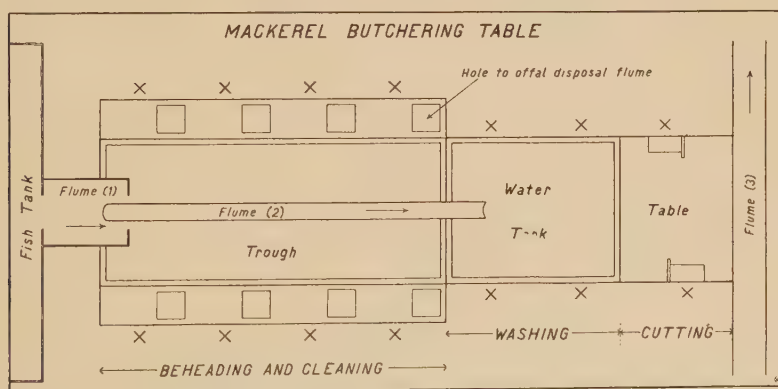


FIG. 63. Diagram of typical mackerel butchering table as seen from above. Workers stand along both sides of the table at the points marked "X". The whole mackerel are flushed into the trough from the storage tank through flume 1. The eight butchers behead and clean them here and throw them into flume 2 above the trough, which carries them into the central washing tank. The butchers drop the heads and intestines through the square holes into a flume that leads to the fertilizer plant. The 4 washers scrape out under water all remaining viscera with spoons, and throw the cleaned fish to the two cutters at the table at the right of the drawing. The cutters sever the tail and cut the fish transversely into two parts, which they drop into the flume (3) leading to the canning room.



FIG. 64. Packing mackerel in one-pound tall cans at a San Pedro cannery. The empty cans are kept in the cardboard boxes above the packing table. The trays of filled cans are carried by hand to the exhaust box. Note difference between this line and one shown in figure 65. Photograph by D. H. Fry, Jr., and author, August, 1931.

against an upright board and make a transverse cut opposite a mark on the table. The anterior or larger piece is about the same length as the height of a one-pound tall can. After this cut is made, the butcher severs the tail which drops to the ground to be washed away later. The pieces of fish are tossed into a flume or conveyor which leads to the packing room or are placed in baskets which are carried to the canning room. In butchering by hand an allowance can be made for the length of each fish and the cuts can be made so as to result in a minimum of loss. From 1 to $1\frac{1}{2}$ tons of whole mackerel can be cleaned and cut every hour at the average table of 14 workers.

Both the fish butchers and the cutting machine operators are paid on a time basis.

Washing

After the butchering the fish are washed. Practices at the several canneries vary considerably for this procedure. It was formerly the general custom to soak the cut pieces in a saturated brine solution for $1\frac{1}{2}$ to 2 hours. This is an excellent practice, as the salt not only removes the slime and does away with certain objectionable odors and tastes often present in the mackerel but also imparts a firmer texture to the flesh. Evidently for reasons of economy and a desire for speed, many of the canneries have abandoned the lengthy brine bath. Brining adds about three cents to the production cost of each case and delays packing for two or three hours.

At one cannery the cut fish are held in a tank of brine only until the tank is partly filled with fish, after which the pieces are removed

to the canning tables as fast as more pieces arrive from the butchering room. This practice results in an uneven brining. Some fish soak too long and become rather tough, whereas others receive no more than a rinse. At other canneries, the cut pieces are merely washed with a stream of either brine or fresh water.

Not all the canneries have abandoned the brine soak, however, and it is hoped that the others will return to it.

Canning

The packing room is located at some distance from the butchering room, sometimes upstairs. Most of the packing rooms are dry and airy in contrast to the dark, wet portions of the cannery where the butchering is done.

The appearance of the packing tables or "lines" and the methods used for packing are practically the same at all the canneries. The packers are all women or girls of every nationality—American, Mexican, Italian, Slavonian, Japanese, and others.

The girls are placed along a table at regular intervals. Beside or in front of each one is a case of empty cans which the girls fill. As each case is used, a straw boss replaces it and punches the girls' piecework card.

The pieces of fish come from the tank or trays, where they have been washed, on a belt conveyor at the level of and immediately across the table from the girls. (See Fig. 65.) The girls divert a number of the pieces onto the table with a board until there is a pile in front of each one. Then they fill the cans by packing the center pieces first and filling the spaces with butt pieces, until each can is visibly full and overflowing. The optimum fill weight of raw, cleaned fish packed in No. 1 tall cans is 17 ounces. (Lang and Fellers, 1929.) Less than about $16\frac{3}{4}$ ounces results in a loose pack that is apt to break up under the usual rough handling that freight in transit receives and more than $17\frac{1}{2}$ ounces results in an overfilled can. Balance weights should be used but seldom are.

Cooking

The girls, often assisted by the straw boss, place the filled cans on a belt conveyor that is located above the cut-fish belt. This conveyor carries the cans past an inspector who cuts off the excess pieces from overfilled cans and adds more to slack-filled cans. In some canneries an automatic salt dispenser drops a small amount of salt into each can as it passes under it. The belt continues, carrying the cans into a long exhaust box containing live steam under no pressure. The passage of the cans through this cooker requires about 20 minutes. In the exhaust box, the vacant places become filled with live steam which condenses, when the can cools, and causes a vacuum.

The cans emerge from the exhaust box, still on the conveyor, to enter the sealing machine. In the canneries where no dry salt has been added, the cans pass under a stream of hot brine before being sealed. Some canneries apply both dry salt and brine. The liquid fills the empty spaces as well as salting the fish. The lid machine tamps the projecting fish, if any, down into the can, shearing off all

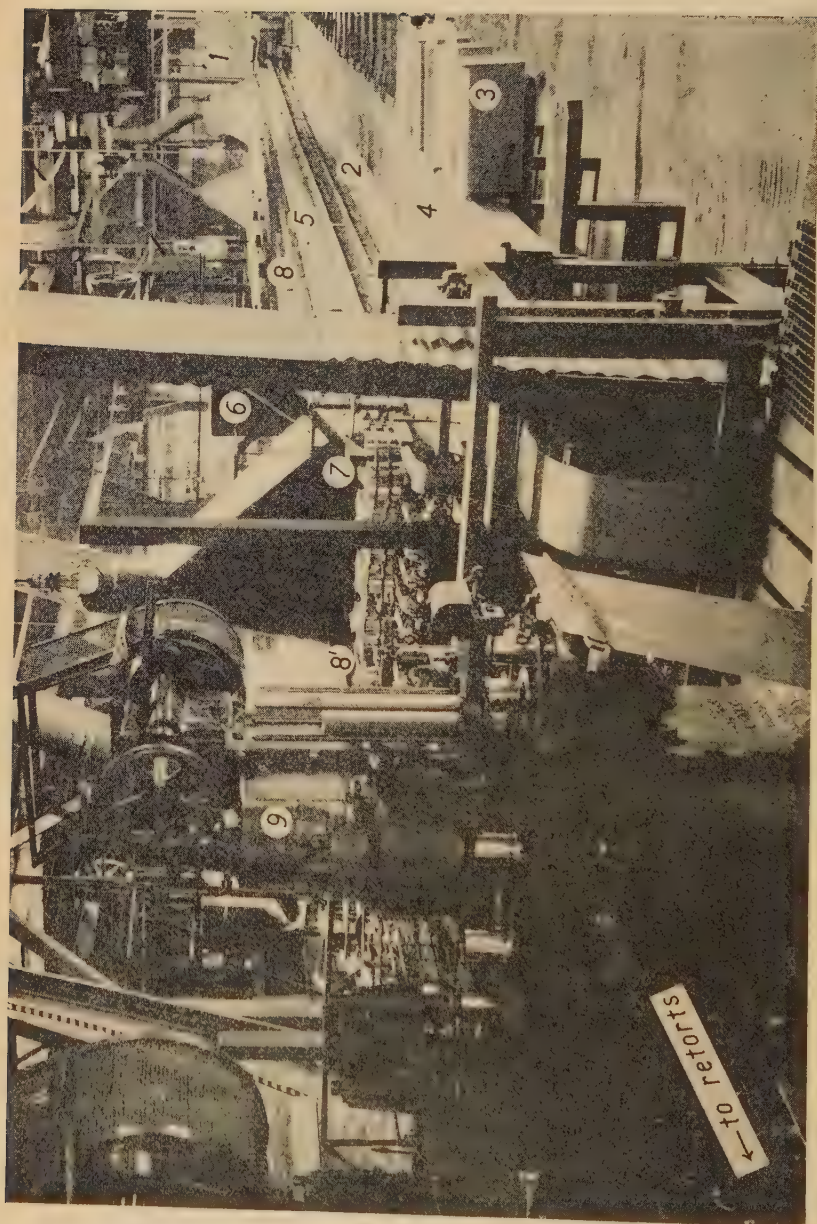


FIG. 65. Mackerel line in a San Pedro cannery, showing packing table, exhaust box and closing machine. The cut pieces of fish come from tank (1) on belt (2) to packers standing between boxes of empty cans (3). The girls fill cans on table (4) and put them on belt (5) which carries filled cans under salt dispenser (6) to exhaust box (8) which they enter at point (7). The cans may be seen making the turns on the "S"-shaped track and emerge at (8'). From exhaust box, cans go to sealing machine (9) and then to retorts. Photograph by D. H. Fry, Jr., and author, 1932.

that will not fit, and seals the cans with the lids. The machine is the standard double seamer supplied by the manufacturer who furnishes the cannery with cans.

The sealed cans are given a rinse in hot water to wash off the adhering fish and are carried by conveyors to the retort room. Here they fall into large iron baskets which when full are wheeled into the retort. In the retort the cans are given a final cooking for approximately 90 to 95 minutes at 240° F. The cooking times and temperatures for retorting and exhausting vary somewhat at the different canneries but the above figures are the average. The aim in view is to give the whole can right to the center a thorough cooking.

The foregoing methods apply to the standard "salmon style" pack in the one-pound tall cans. This style pack is also put up in half-pound tall cans which require a little less cooking.

Weight of Fish Required to Fill Case

Including the liquid resulting from cooking, each No. 1 tall can contains at least 16 ounces of cooked mackerel. The standard 48-can case containing 48 pounds of cooked fish is the product of from 90 to 120 pounds of raw, round mackerel. Due to excessive butchering losses, very small or very large mackerel will yield but 17 cases to the ton, whereas a ton of medium or fairly large fish yields as much as 24 cases. An average of 20 cases per ton is maintained at most canneries but this average may be higher or lower, depending upon the efficiency of the cannery itself.

Labeling and Casing

After removal from the retort the cans are allowed to cool in the iron baskets. The next step is labeling. This is done by a labeling machine that automatically wraps and pastes the brightly colored lithographed labels. The final operation is packing the cans in fiber board or wooden cases, 48 cans to the case. The cases are either shipped out immediately to the jobber for sale or storage or are stored at the cannery until sold.

Horse Mackerel

Mixed in with the mackerel delivered at the cannery there are often numbers of horse mackerel. Some of the canneries will not accept the horse mackerel in quantities but will overlook a small percentage. Sometimes, however, the catch runs as high as 40 to 50 per cent horse mackerel and occasionally a boat brings in a load composed entirely of horse mackerel. Some of the canneries accept these loads, sometimes, however, paying less for them.

When there are but a few horse mackerel, the cannery workers sort them out to take home for dinner. Those that the workers do not save are run into the fertilizer plant along with the offal and any crushed mackerel. When a load containing a high percentage of horse mackerel is accepted, these are butchered and packed with the mackerel. No distinction is made except that the tail section of the horse mackerel must be discarded because of the rough scutes along the lateral

line. The two species are similar in flavor, and if anything the meat of the horse mackerel is firmer and lighter in color.

Other Fish in the Catch

Most of the other fish that find their way into the catches of the cannery mackerel boats are either thrown into the offal flumes or saved by the workers, depending on the species. At no time are there enough of these fish to be of any importance with the occasional exception of the bonito, *Sarda chiliensis*. When a mackerel boat gets a considerable number of bonito in the haul, the crew segregates them out and sells them separately to the fish markets or to the cannery for canning tuna style. If there are but few they are left with the mackerel, usually to meet one of the two fates—fertilizer or cannery worker's dinner. Occasionally, however, a few small bonito—those about the size of mackerel—are butchered and packed with the mackerel as mackerel.

Early Canning Methods

Mackerel have been canned more or less experimentally at different times by many California packers but no great success ever crowned their efforts until 1927. Many of the packs were failures themselves and when they were successful the packers could seldom find a market for the product.

During the World War, quantities of mackerel were more or less successfully packed in southern California. Regarding the canning methods employed in 1917, Cobb (1919, p. 50-51) has this to say:

"Upon arrival at the cannery the fish (mackerel) are scaled, eviscerated, the head, ventral and pectoral fins with their supporting bones removed, then cut to fit cans, and the pieces put into a 75° (salometer) brine and allowed to remain here until the blood had been extracted from the flesh, or about 45 minutes, after which they are lightly rinsed in fresh water. The pieces are then put into the cans, care being taken to see that the cans are packed as tightly as possible and slightly above the top to allow for shrinkage in cooling. This is necessary in order that the pack may stand up well under long distance shipment.

The cans are then inverted and cooked in steam at 2 to 3 pounds pressure for 45 minutes. After removal from the retort the cans are allowed to drain 30 minutes or longer. The cans are then reversed and the pieces of backbone removed. This makes practically a boneless product and adds much to its value at but little cost. One-third to one-half fluid ounce of cottonseed or corn oil is then added. The cans are then exhausted for about 10 minutes at 212° F., sealed, and processed 1½ hours at 240° F., or 2 hours at 230° F.

Some cannery pack in a bouillon. In this method the head and trimmings should be saved. In making the bouillon 10 gallons of the washed heads and trimmings should be placed in a soup kettle; to which add 12 gallons of cold water, 2 pounds chopped onions, a bunch of parsley, 1 pound of chopped carrots, ½ pound whole juniper berries, ¼ pound ground white pepper, 2 ounces ground red pepper. Bring to a boil then simmer gently one or two hours. The liquid should then be strained and 3 per cent of salt added, when it is ready to be poured in the cans with the fish, in place of oil, after which the cans are handled the same as described above, except that they do not have to be exhausted if the bouillon is put in the can hot.

Quite small mackerel are obtained in considerable quantities, and these are prepared in the same manner as sardines, and packed either in oil, mustard or tomato sauce."

Marketing Canned Mackerel

Canned mackerel is usually sold by the canneries through jobbers. The canners themselves seldom try to sell the mackerel to scattered distributors but prefer to have the big San Francisco and Los Angeles firms handle all deals. The large wholesale grocery companies generally take care of domestic sales and the San Francisco import and export brokers handle sales to foreign buyers. The jobbers store the canned fish in their own or the canneries' warehouses until they sell it to the local wholesalers and retailers. Foreign and east coast shipments are made by ship and inland markets are supplied by rail.

The greatest part of the mackerel pack is consumed in the United States. Independent and chain grocery stores throughout the country

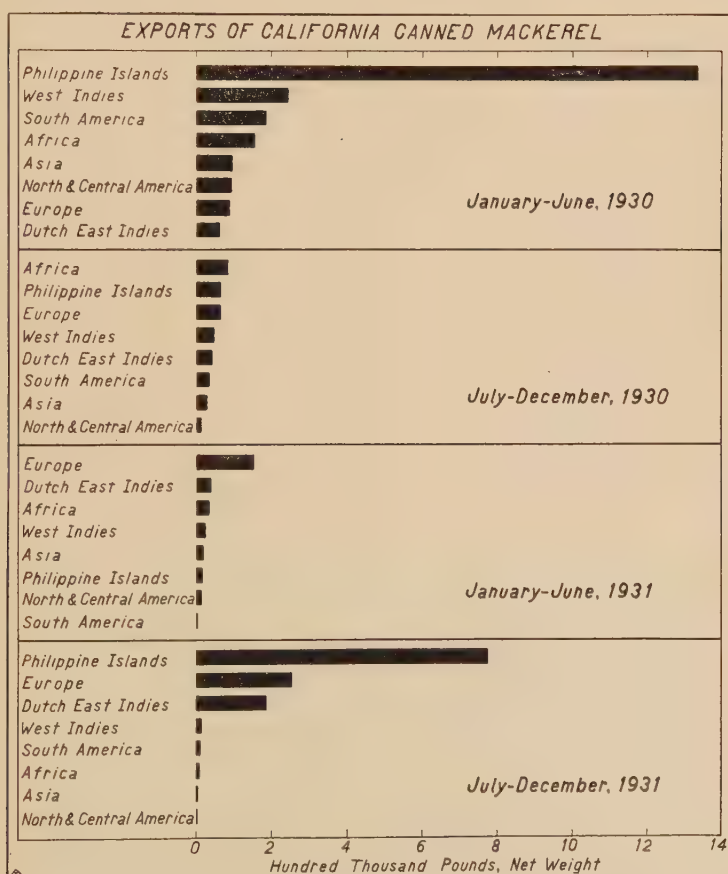


FIG. 66. Exports (by six-month periods, 1930-1931) of canned mackerel from California to the various parts of the world. Figures are from reports of the United States Department of Commerce. Separate figures for mackerel exports were not collected prior to 1930.

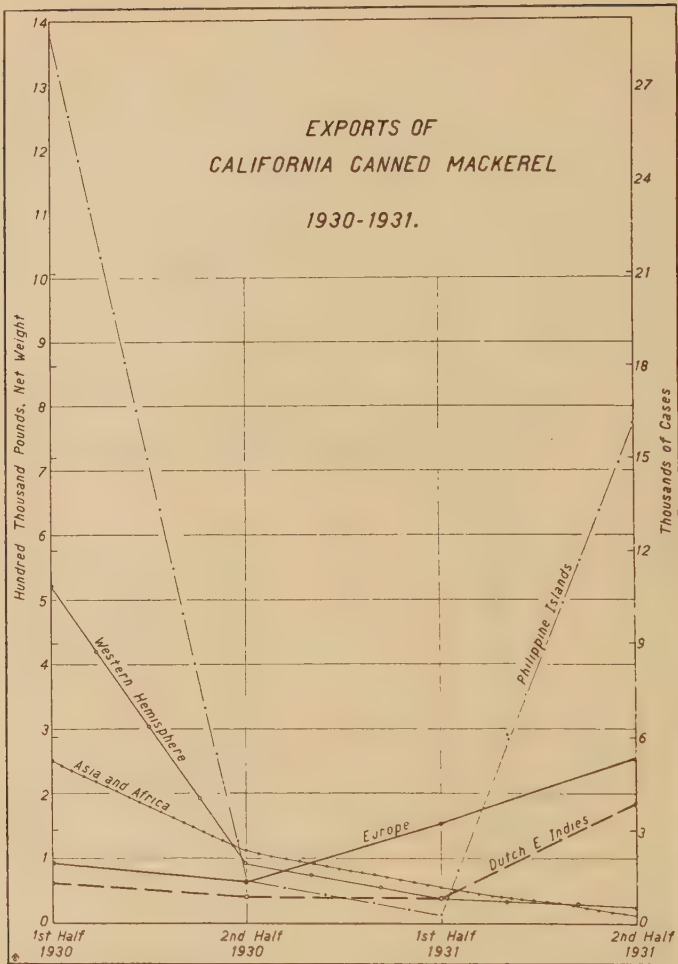


FIG. 67. The trend of exports of canned mackerel from California to the various parts of the world. Note that the markets in the western hemisphere (except the domestic market) and in Asia and Africa have been lost and that exports to Europe and the Dutch East Indies have shown a gratifying increase. The Philippine Islands, once the best market abroad, slumped badly for a time but have again risen to first place. Figures are from the reports of the United States Department of Commerce. Cases are each 48 pounds net.

sell California canned mackerel in competition with pink salmon. The heaviest sales are made east of the Mississippi, particularly in the States south of the Mason and Dixon line. Because of the heat in the South, fresh fish does not keep well, and many communities depend on cans for their entire fish supply. Moreover, colored folks are very fond of canned fish. Mackerel is a favorite because of its low cost as well as its fine flavor.

Foreign sales were at first the backbone of the mackerel industry. The largest part of the 1928 pack and considerable of the 1929 output

were exported. The Philippine Islands took most of the pack. Exports fell off in 1930, those to the Philippines suffering the worst decline. Demoralized business conditions abroad were the cause of the drop. Prohibitive tariffs killed the export trade to South America. With a lower price level in effect in 1931, mackerel exports staged a partial comeback. More was shipped to Europe than in 1930 and exports to Manila picked up in an encouraging manner. However, the packers must come to depend on the domestic trade, which, if pushed a little with careful advertising and sustained good quality, would be sufficient in itself to support a fair sized industry.

SALTED MACKEREL

Method of Preparation

Large quantities of mackerel and horse mackerel are salted at Monterey and San Pedro and smaller amounts are put up at other California fishing towns. As salting fish is a rather simple procedure, a number of wholesale fish markets and canneries pack salted mackerel on the side. Although it is easy to make fairly good salted fish, it requires a skilled salter to produce a really excellent pack. The services of such people are generally at a premium. Many of the salters are Scotch women who learned the business in their home country.

Rather small mackerel, those about 13 to 15 inches long, are used. This size is the best seller.

The splitter takes the fresh, uncleaned fish and holds it down on the cleaning table with her left hand. She inserts a sharp knife into the back immediately anterior to the first dorsal fin, just to the side of the backbone, and carries the cut forward to split the head. Then she inserts the knife into the original slit and cuts the body of the fish back to the tail. The mackerel is now in two parts, joined only at the belly. (See Fig. 68.) Using her knife, the splitter scrapes out the entrails, gills and blood, and in the case of fairly large fish makes a

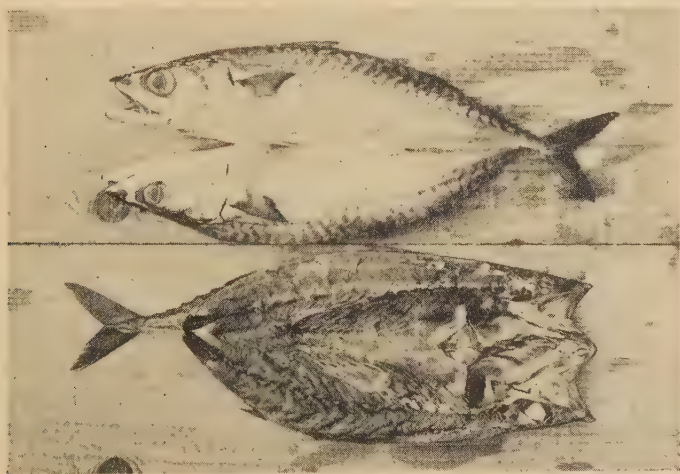


FIG. 68. Mackerel split and cleaned, ready to be salted.
Photograph by author, October, 1931.

cut under the backbone to allow better salt penetration on the thick side. Sometimes women assistants do the cleaning and scraping. A good splitter can keep two or three cleaners busy.

After splitting and cleaning, the fish are thoroughly washed and soaked in salt water. If fresh water were used the mackerel would become rather soft.

The fish are now ready for salting. The salter first sprinkles them thoroughly with fine salt and rubs it into the flesh. The actual curing is done in a variety of containers of all sizes—tubs, firkins, kegs, barrels, and hogsheds. A layer of salt is sprinkled over the bottom of the container and the split and salted fish are laid on it, skin side down, as many as will fit without overlapping. More salt is sprinkled liberally over this layer of fish and more mackerel are added, alternating with salt until the barrel is full. An ordinary 200-pound barrel will hold about 320 mackerel and requires one 100-pound sack of salt. A tight-fitting lid is put over the barrel to exclude flies and dirt and the barrel is left for 10 days. The dry salt draws out the natural moisture of the fish to form the brine.

It is important that the salt used be as pure (containing only sodium chloride) as it is possible to obtain. Very small amounts of sulphates, magnesium salts, and especially calcium salts retard the penetration of salt into the fish, so that when they are present spoiling is apt to take place before the fish is cured. These impurities also tend to make the fish hard, bitter and chalky white, all objectionable features.

After soaking for about 10 days, the mackerel are removed and repacked in the container in which they are to be shipped or held until sold. This container is usually a small barrel or kit holding about 80 fish. For repacking, the fish are given a light salting and packed dry in the kit. Brine is added to fill the kit. Salted mackerel if properly packed will keep indefinitely. Before cooking, it is advisable to soak the fish for 12 hours or more in several changes of fresh water in order to remove the excess salt.

The Pacific mackerel is said to be somewhat inferior to the Atlantic species for salting because when salted its flesh is claimed to be darker and coarser. However that may be, properly salted California mackerel is an excellent food product and should enjoy a larger market than it does.

Salted horse mackerel is prepared in exactly the same manner as salted mackerel.

Markets for Salted Mackerel

The largest sales of salted mackerel are made to steamship owners who consider it a convenient and economical article of diet for their crews. Salted mackerel finds a limited market in the foreign population of California. Former Eastern people residing in California buy salted mackerel because they acquired a taste for it on the east coast where it is a great favorite. Small quantities are shipped east to help meet the big demand that the Eastern mackerel can not completely supply.

HARD-SALTED MACKEREL

Methods of Preparation

Two plants at San Diego hard-salt several species of fish, including small amounts of Spanish mackerel. The method of preparation is as follows: The fish are split open from the back, leaving the two halves connected at the belly. The viscera are removed and the head is severed. Salt is sprinkled all over the fish and rubbed into slits which have been made at various places. The floor of the saltery is covered with salt upon which the freshly salted fish are placed. Then alternate layers of salt and fish are piled up. The fish are left alone until the moisture has ceased to run—a matter of a week or two, usually 10 or 12 days. Then they are spread out on racks in the sun until quite dry. One day of sun-drying is sufficient in the summer but two are necessary in the winter. If the fish are too dry and hard they do not sell well, if not dry enough they spoil, so it is important to work with the greatest of care. The dried fish are packed in boxes, flesh to flesh, for shipment.

Nearly every one of the fish markets on the wharf at Monterey dries small amounts of mackerel and horse mackerel, among other species, for retail sale. The process is similar to the method in use at San Diego. All sizes of both species are used but the very small ones—those about 6 inches long—seem to be preferred. The salted fish are put in shallow trays and placed on the market roofs for the sun-drying. Owing to the damp climate prevailing at Monterey, more than one day is necessary to dry even the smaller fish.

The Japanese fishermen on Terminal Island and at San Diego dry various kinds of fish, including mackerel and horse mackerel, for their own use. They place the fish in screen trays which are hoisted to the tops of tall poles to expose the fish to the sun and get them away from flies.

Markets for Hard-Salted Mackerel

Hard-salted Spanish mackerel are sold almost exclusively to the Portuguese population of San Francisco.

The hard-salted mackerel and horse mackerel produced at Monterey are sold locally to Italians, Japanese and Filipinos.

KIPPERED AND SMOKED MACKEREL

Methods of Preparation

Mackerel are ideally suited for kippering or smoking and have been so prepared in California for many years.

Kipperd mackerel is prepared on a wholesale scale in the following manner: The mackerel, large ones preferably, are gutted and beheaded. They are then thoroughly washed in a stream of fresh water and the body cavity is scrubbed with a motor-driven rotary brush. An overnight soaking in brine follows. The salt removes the slime and draws out the blood which is carried away in a second washing. The fish are then hung by the tails in the smokehouse and subjected to the cold smoke of a hardwood fire for about 20 hours. After

being smoked, the now golden-hued mackerel are done up in individual cellophane wrappers. They will keep indefinitely in cold storage.

The mackerel that are hot-smoked for retail sale by a number of small operators in southern California are given a somewhat different treatment. Only the very smallest ones are smoked without being split. The large ones are split from the back in the same manner as mackerel are prepared for salting. The fish are smoked over a hot fire for a few hours—the time depending on the personal opinion of the smoker—so that they are as much cooked as they are smoked.

Markets for Smoked Mackerel

The cellophane-wrapped kippered mackerel are marketed for the most part in San Francisco. The fish keep longer out of cold storage in the cool weather of that city than in southern California. Some are sold in Los Angeles during the winter, however. Kippered mackerel have proved to be popular with all classes of people and meet a ready sale from all nationalities.

The smoked mackerel produced at the beach resort towns are consumed locally. Tourists, picnickers and pleasure fishermen are the best buyers.

CANNED FISH CAKES

Packing Method

At various times Japanese interests have operated fish cake canneries in the San Pedro district.

The fish commonly used in the manufacture of fish cakes is the barracuda (*Sphyræna argentea*). However, at times when barracuda are scarce, mackerel are utilized. The mackerel are not so desirable as the meat is darker and does not fry together so well.

The process of manufacture is as follows: The light meat of the fish is ground very fine in a rotary mixer. The ground fish is put into a hopper which has several holes, about $1\frac{1}{2} \times 1$ inch, in the bottom. The weight of the mass above forces the fish through the holes in steady streams. A wire, moving back and forth, cuts the sticky stream of fish at regular intervals to form separate cakes. Before the cakes have a chance to fall apart they drop into screen baskets in a tank of boiling cottonseed oil. The hot oil cooks them into firm, oval cakes about $1\frac{1}{2}$ inches long and $\frac{1}{2}$ inch thick. The baskets of cakes are moved along the lengthly open trough or tank of oil by the operator. The baskets are taken out at the far end of the trough after being immersed for about 10 minutes in the oil, which is held at a temperature of 230–240° F. The cakes are allowed to drain and cool in the open air. After cooling they are packed in cans by hand. The can that is commonly used is the half-pound tall, key-open can. The cans are sealed by machine and retorted for 80 minutes at 240° F. to complete the process.

Market for Fish Cakes

The market for fish cakes is very limited and easily oversupplied, as several manufacturers have discovered to their loss. Although Americans occasionally buy a can or two out of curiosity, the only buyers of consequence are Japanese living in the United States.

CANNED ANIMAL FOOD

Packing Method

Early in 1931 one of the San Pedro group of canneries commenced to manufacture dog food from fish on an experimental scale. The experiments were successful and operations on a commercial scale were begun during the summer. The fish first used was the mackerel, which has proved to be satisfactory.

As but one cannery is using the process, which has been developed at that cannery, it will not be possible to enter into details that will divulge trade secrets. Suffice it to say that the whole mackerel are run into a large "hamburger" machine where they are ground into a fine mass. From here they go into an exhaust box, where with the addition of a special blend of flour they are churned and steam-cooked. The cooked combination flows into cans which are capped, washed and finally retorted. The pack is in 1-pound tall cans, 48 to the case, and in No. 10 cans, 7 pounds each, 6 to the case.

Markets for Animal Food

The new product has met with a ready sale. Dog and cat owners throughout the United States have taken to the new pet food and repeat sales are universal. Chain and independent grocery stores handle the retail sales. Fox farms in several western States have become enthusiastic users. State and private fish hatcheries in a great many States throughout the country have placed large orders, the operators declaring that the blended food is beneficial to their fish in

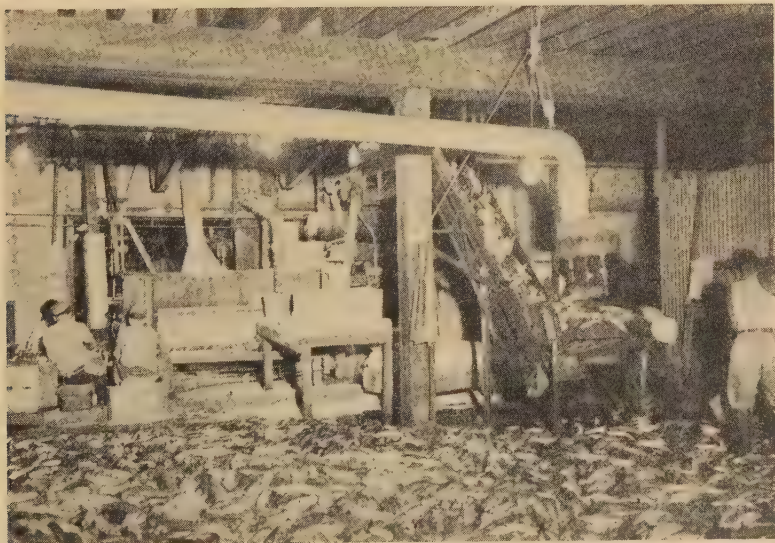


FIG. 69. The machine for manufacturing animal food from whole mackerel at a San Pedro district cannery. The men at the left are filling the one-pound tall cans, which are capped at a sealing machine to the left beyond the picture. Photograph by D. H. Fry, Jr., and author, August, 1931.

every way. Pet owners purchase 1-pound cans and fox and fish farms owners buy the 7-pound cans.

A carefully planned and skillfully executed radio, magazine and newspaper advertising campaign has had considerable to do with the startling success of animal food made from fish.

SUMMARY

Fresh and canned mackerel are the principal products of the California mackerel fishery.

Mackerel are sold fresh, after cleaning, in all parts of California and to some extent in neighboring States.

The production of canned mackerel is a major industry. The greatest part of the pack is put up in 1-pound tall cans. The fish are beheaded, cut in two pieces and cleaned, either by machine or by hand. The pieces are packed in the cans by hand. The open cans pass through an exhaust box, salt or brine is added, and the cans are sealed and finally retorted. Canned mackerel is exported to nearly every country in the world and enjoys a fairly large market in the United States, particularly in the southeastern States.

Several other products are manufactured from mackerel. These include salted mackerel, hard-salted mackerel, smoked and kippered mackerel, canned fish cakes, and canned animal food.

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VIII. SPORT FISHING FOR MACKEREL

A POPULAR GAME FISH

Sport fishing is primarily a recreation, but it can also be classed as a business. In California there are 250,000 licensed anglers and many thousands more who confine their fishing to the capture of non-game fishes. When this army takes the field, it requires a great many tackle and camping supply dealers to fill its wants. Resort keepers profit from the sportsmen who go far afield in search of better fishing. Many men make a living by conducting deep sea or pack train fishing trips. The selling of bait and renting of boats is a big business in some places. The recreational value of our fish can not be figured in mere dollars and cents but the fact remains that sport fishing directly or indirectly supports thousands of California residents.

The value of sport-caught fish is appreciable. Many people fish for food as much as for sport. The amounts of fish that non-commercial fishermen catch and subsequently eat, give away, or sell are considerable and compete to some extent with commercially caught fish.²³ Many anglers who have made good catches sell their surplus fish to wholesale or retail markets or to their boatmen, who resell them. Those fish, although most of them do not enter any catch statistics as yet, are nevertheless a competing factor which must be considered in a discussion of our commercial fisheries.

To mention California sport fishing is to bring thoughts of mountain trout, salmon, striped bass, leaping tuna, or swordfish. But not all of the many who seek recreation in fishing are able to try for those famous game fish. To many, the expense of traveling long distances or of purchasing costly tackle is prohibitive. For the majority of anglers there are other fish that are perhaps less publicized but are possessed of excellent food and game qualities. There is scarcely a part of California that has no fishing of some description or fishermen to take advantage of it.

The part played by the mackerel in salt water sport fishing is an important one. Practically every one who has fished in coastal waters between Santa Cruz and San Diego has first-hand knowledge of the splendid fighting qualities of the Pacific mackerel. Monterey Bay anglers prize the mackerel which is not too easily caught in their region. In southern California, however, the mackerel can readily be taken in quantities, and as is the usual fate of a common fish it is despised and cast aside by many. Such a state of affairs is inevitable, however meritorious the fish may be.

The runs of mackerel at Santa Cruz, Monterey, Morro, and Santa Barbara are irregular and often unexpected. It is usually a matter of chance that schools are discovered by wharf or boat fishermen. The chances are better in the summer. At irregular intervals of several

²³ In this connection we consider the non-commercial fisherman one who has no commercial fishing license and who sells fish only occasionally and not as a business. It has been said that the commercial fisherman sells fish to make a living and the angler sells fish to make some money.

years, wandering schools are encountered by sport fishermen as far north as Princeton on Half Moon Bay. During the summer, Santa Cruz fishermen are sure to happen upon mackerel at some time or other. The Monterey pleasure fishing boats catch mackerel at irregular intervals throughout the year. Boats fishing off Morro and Avila occasionally encounter schools during the course of a summer. A short distance offshore from Santa Barbara there is anchored a fishing barge from which mackerel are caught from time to time the year round. Fishermen using the barges anchored off Point Mugu during the summer make good catches of mackerel.

From Santa Monica to San Diego the mackerel is the all-year standby of the barges and angling boats that operate from nearly every seaside town. Every week thousands of people take to these craft for recreation and incidentally to obtain fresh fish. Summer-time sees the largest crowds but many operators do a good business during the balmy southern California winters. Nearly everyone who pays the price and goes out catches some fish, often a sackful. This is not in the nature of an advertisement—it is a fact. Nearly always the greater part of the catch is composed of mackerel. This is especially true in the winter when many other fish are relatively scarce. There are always those anglers who scorn to fish for anything less than yellowtail or black sea bass, but the majority fish for whatever they can get—and the mackerel, for one, rarely fails them.

The amount of mackerel caught in southern California by sport fishermen is huge. Actual figures are not available and no estimate can hope for complete accuracy.²⁴ For any one of 25 or so barges, 500 pounds of mackerel would be but an average day's landing. A year's fishing from barges, boats and piers undoubtedly accounts for many hundreds of tons of mackerel that are used for food or bait.

Most of the mackerel caught by pleasure fishermen are used fresh as food by the anglers and their friends. Some are sold to acquaintances, fish markets or boatmen. Some are cast aside to be sold by the boatman, salted for bait, or thrown away. Many are used as bait, either alive for black sea-bass (jewfish), swordfish or tuna, or cut in small pieces for nearly every kind of fish, including mackerel. Salted mackerel is a fair bait used when sardines or fresh mackerel are not available. Ground fresh mackerel is used as chum to attract fish within catching distance.

In the following account of sport fishing methods, no attempt is made to give directions for catching mackerel; any boatman or sporting goods dealer can advise a prospective fisherman on fundamentals, and experience alone can teach the finer points. The account will list types of boats and gear as a basis of comparison with commercial methods and with the tackle used in other places or that employed in taking other species of fish. No discussion of mackerel fishing gear could be complete without a brief description of the various kinds of sport tackle that catch so many mackerel.

Mackerel are rare north of Monterey Bay so there is practically no sport fishing for them above Santa Cruz. When anglers go south of San Diego they are seeking big game fish, and mackerel interest

²⁴ As this is written (1931), the California Division of Fish and Game is putting into operation a plan for gathering sport fishing statistics.

them only as bait. The strip of coast between Santa Cruz and San Diego, then, is the area where the mackerel is most sought for, both by sportsmen and commercial fishermen. Located approximately in the middle of this bit of coast line is Point Conception, a line of demarcation between two distinct types of fishing. The character of the shore and the temperature of the water are different on either side, so many southern fish seldom wander north of the point and most northern fish stay on their side. The mackerel ranges on both sides. Methods of fishing differ to the north and south, however, so Point Conception is a convenient dividing line for the purposes of this discussion.

CENTRAL CALIFORNIA

The only place in central California where mackerel can be caught in any numbers with some consistency is at Monterey. At times mackerel fishing at Santa Cruz is good. Fishing parties from Morro and Avila sometimes have good luck with mackerel but not consistently.

Fishing from a boat is the best way to catch mackerel at Monterey as elsewhere. A number of individuals and companies operating a half dozen boats take out pleasure fishing parties. Their boats leave on regular schedule and have fixed prices for passengers. If desired, parties can charter entire boats. The trips last all morning or all day, depending on the boats and the prices paid, or until too many people become seasick. The boats are various types of commercial fishing craft, 35 to 60 feet long, or small cabin cruisers. Bait and hand lines or short pole lines are provided but many fishermen prefer to use their own tackle.

The boats usually fish within a mile or two of shore off Pacific Grove. When the fishing grounds are reached, the boat is anchored. Chumming begins immediately. This consists of throwing quantities of freshly ground fish into the water to attract and concentrate nearby schools. The fish most often so attracted and subsequently caught are mackerel and various species of rockfish.

As soon as the fish begin to swarm about the boat, fishing commences. The hand lines, each bearing one or more hooks and a weight, are lowered to the right depth and if the fish are as hungry as usual the fun soon commences. Small pieces of fish are used as bait. In general the rockfish are found deeper than the mackerel but for both the depth varies greatly from day to day and with the seasons. The water is usually so clear that the angler can see the fish he seeks and can easily judge how deep his line should be fished.

It is relatively easy to haul the fish aboard with a hand line, so those desiring the maximum of sport employ light rod and reel outfits. For this type of fishing, the 5- or 6-foot black bass rod of steel or split bamboo and a quadruple multiplying reel with 100 yards of 6-thread linen line have been found ideal and are used by a great many fishermen. Others prefer an 8- or 9-foot split bamboo trout rod. Both are used extensively and are real sporting outfits. The mackerel caught on light tackle is one of the gamest fighters that swims, making numerous swift, powerful runs before yielding. As it takes less time to haul in each fish by the hand-over-hand method, the hand-liners usually carry larger sackfuls ashore.

Occasionally schools of small mackerel come in close to the shore at Monterey. At these times mild sport can be had fishing from the Municipal Wharf with bits of bait on small hooks or with snag hooks. These 6- and 8-inch mackerel have a delicious flavor but because of their small size they are scarcely worth catching. At times, adult mackerel can be taken from one or another of the wharves. (See Phillips, 1932.)

As the number of people fishing at Monterey is much smaller than at the southern California beach towns, the sport mackerel catch does not approach that of the south in magnitude. Nevertheless, the amounts caught are considerable.

Tourist visitors to Santa Cruz, the resort town across the bay from Monterey, support a small fleet of pleasure fishing boats. Here sport fishing trips are conducted as at Monterey but the summer time is the big season with practically no fishing in the winter. The mackerel run in midsummer only but at that time they are very abundant. Pier fishing is popular at Santa Cruz. There is some boat fishing at Moss Landing during the summer.

The salmon and rock cod boats at Princeton take out pleasure fishing parties in the summer. The fish most often caught are perch, smelt, rockfish, and salmon. At rare intervals good mackerel fishing is to be had but the appearance of the mackerel is uncertain.

Extending many miles south of Monterey is a rugged, harborless coast where small pleasure boats dare not venture. The first town to the south where there is any organized pleasure fishing is Cayucos. Here, one or two fishermen take out parties that occasionally encounter mackerel.

Morro Bay is the headquarters of several pleasure fishing boats. Fishing parties put out from the bay to fish in the ocean for rockfish, yellowtail, barracuda, mackerel, etc. During the summer mackerel fishing is fairly good but the fish are not found in numbers comparable to the schools frequenting Santa Monica Bay, for instance. The usual method of fishing with a baited hook is sometimes employed. Often the mackerel take the hooks intended for other fish. In addition to the baited hook, the Morro fishermen use another type of lure that is not prevalent in the mackerel fishery elsewhere in California. It is the so-called "Colorado trout spinner," a concave piece of brass, about an inch long, that revolves and shines brightly when drawn through the water. It bears either two single hooks or one triple hook. It is trolled on a light line behind the boat. Mackerel, jack smelt and other fish are attracted by its glitter and strike it either in anger, curiosity, or thinking it is a small fish.

At Avila, a number of the commercial fishing boats, in addition to several regular charter boats, take out pleasure fishing parties. In the summer the mackerel is one of the species caught. Cut fish is used as bait. At irregular intervals during the summer, schools of mackerel strike in close to the shore, at which times the pier fishermen at Avila take toll of them.

Avila is the southernmost town of the central California group of fishing ports. At times, fishing is to be had from the wharf at Pismo Beach, a few miles south, but practically no mackerel are taken between Avila and Santa Barbara.

SOUTHERN CALIFORNIA

Where to Fish

Mackerel are caught in considerable numbers by sport fishermen in the neighborhood of practically every town between Santa Barbara and San Diego. The fishing, all hook and line, is carried on in four general ways—from piers, from private or charter boats, from anchored barges, and from live bait “open” boats. The methods employed in each of these types of fishing differ very little from place to place so that the entire area can be discussed as though we were dealing with one place.

Before considering fishing methods, a list of the towns where mackerel are caught will be given. The following list gives the fishing facilities at each of the towns as for the summer of 1931. At most of the places listed, charter boats can be had but as they are seldom used for mackerel fishing they are not included.²⁵

<i>Town</i>	<i>Piers</i>	<i>Barges</i>	<i>Live bait boats</i>
Santa Barbara -----	x	1	--
Summerland -----	x	--	--
Carpinteria -----	x	--	--
Ventura -----	x	--	--
Hueneme -----	x	--	--
Point Mugu -----	x	1	1
Santa Monica -----	x	3	5
Ocean Park -----	x	2 ^a	2
Venice -----	x	1	2
Playa del Rey -----	x	--	--
Manhattan Beach -----	x	1	1
Hermosa Beach -----	x	2	1
Redondo Beach -----	x	3	3
San Pedro -----	Breakwater	3	1
Avalon -----	x	1	--
Long Beach -----	x	2	5
Belmont -----	x	-- ^b	--
Seal Beach -----	x	--	--
Huntington Beach -----	x	1	--
Newport -----	x	3	3
Balboa Beach -----	x	--	--
Laguna Beach -----	x	1	--
Capistrano Beach -----	x	--	--
San Clemente -----	x	1	2
Oceanside -----	x	1	1
Del Mar -----	x	--	--
La Jolla -----	x	--	--
San Diego -----	x	2	3
Totals -----	27	29	30

^a One of the Santa Monica barges has a shore boat that also lands at Ocean Park.

^b One of the Long Beach barges has a shore boat that also lands at Belmont.

At times live bait boats or barges make an appearance at other towns or at some of the above places during the height of the season only to disappear with the coming of cold weather. There are small private piers at several points along the coast that are not listed.

²⁵ This list has been taken almost entirely from the magazine, *The Fisherman* (later known as *The Fisherman and Hunter*), Los Angeles.

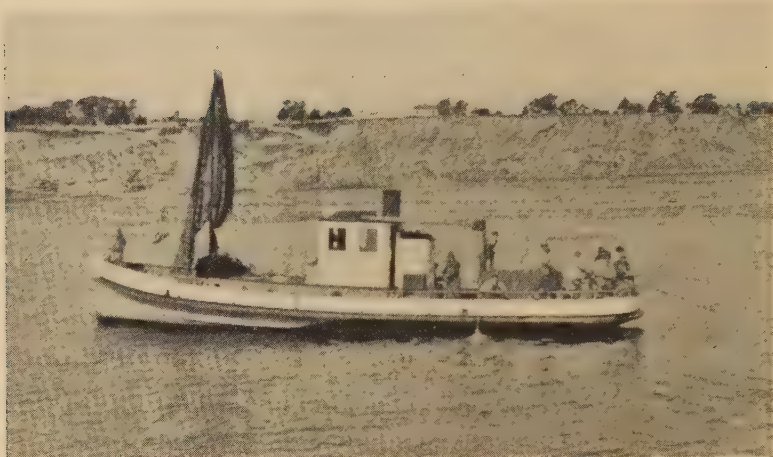


FIG. 70. Live bait pleasure fishing boat at anchor off Point Firmin, San Pedro. Note the bait net hanging on the mast to dry. Photograph by author, January, 1931.

Patrons often fish from the cabaret barges that are anchored off Long Beach.

Pier Fishing

A comparatively small number of mackerel are taken from the long piers that extend out into the open ocean and the unsheltered bays along the coast of southern California. The mackerel is essentially a pelagic or offshore fish, and although individuals or small schools often come around the wharves, the large schools stay in open water. Occasionally a good run strikes in at some wharf but pier fishermen can not count on a good catch of mackerel. A few are sure to be caught every day from nearly every wharf but not many. The young ones come in more often than the adults but they are too small to afford much sport.

Most pier fishermen who are fishing for whatever they can catch use hand lines or heavy rod and reel outfits with several hooks and heavy sinkers. The most popular baits are clams, pile worms and cut fish, the latter being the best for mackerel. The heavy tackle is effective but the sheer weight of the outfit is enough to slow any fish of less than 10 or 15 pounds so the game qualities of the mackerel do not show to advantage. The piers are very high above the water so that fairly heavy tackle is necessary for lifting fish to the deck.

When the fisherman is trying especially for mackerel or bonito, he uses live bait or some sort of artificial lure on a short line and long pole. The poles are of whole bamboo, 10 to 18 feet in length. The line, which is tied direct to the end of the pole, is rather short. For feather jig (striker) fishing, it is but a couple of feet long, barely enough to reach the water. For live bait or metal jig fishing it is usually about the same length as the pole. When using a feather jig (see Fig. 47), the angler swings the rod back and forth rapidly and continually so that the lure describes a sort of figure eight at or just below the surface of the water. The bonito and mackerel probably mis-

take the seemingly aimless maneuvers of the feather lure for the bewildered movements of an injured fish. When using a metal jig, the angler allows the jig to sink and then draws it swiftly toward the surface. Because of its shape, the shiny jig swerves and darts like a wounded fish. It is especially effective for queenfish, barracuda and halibut but mackerel sometimes seize it. The jig usually bears enough hooks so that it snags any fish that are in the neighborhood of its activities. Live bait fishing is simple if the bait can be had. At the end of the line there is a gut leader, 2 to 5 feet long, to which the hook is tied. The fish to be used as bait is put on the hook and lowered to the water. It is allowed to swim about until it dies or a fish seizes it. Each fisherman has his favorite way of impaling the bait on the hook—some attach it through the upper lip, some use the lower jaw, others prefer to run the hook through the back, belly or tail. Young smelt, anchovies and especially sardines are used.

The method of catching the bait from some piers is ingenious. Schools of young fish are usually to be seen swimming around the piers. The concessionaire who sells bait and rents tackle lowers a piece of screen to a depth just below the usual depth at which the small fish swim. When a number of fish are directly above the screen the operator hauls it up rapidly by hand with a windlass, bringing some fish up with it. The fish are kept alive in screen live boxes suspended in the water. Some piers are supplied by live bait fishing boats. On others the anglers are obliged to catch their own bait with snag hooks or do without.

The feather strikers and live bait are the most effective lures for pier mackerel.

Private Boats

A relatively small amount of fishing is done by southern California anglers from their own boats. The boats range from outboard-powered skiffs to large motor cruisers and sailing yachts. Some were built specially for fishing but most of them are pleasure boats that are used occasionally for fishing. The harbors where these boats are kept are at Santa Barbara, Los Angeles Harbor, Long Beach, Newport, San Diego, and Avalon.

Usually the owners of the boats built for fishing, angle for big game fish but when the big ones are not running they will sometimes get out their light tackle and fish for bonito, barracuda and mackerel. The owners of some of the boats fish principally for those three species as they can be taken most easily and within a short distance of port.

The boats either anchor and those aboard fish with cut bait, or at other times they are kept going, and feather or bone jigs are trolled astern.

The amounts of mackerel taken by the privately operated pleasure boats are insignificant.

Live Bait Boats

One of the most popular types of angling in southern California is fishing from the live bait excursion boats. The boats leave the towns mentioned previously at regular hours every day. In addition, parties desiring more elbow room and privacy can charter boats. At a few

places charter boats are all that can be had. The operators usually furnish live bait but in a few instances the fishermen must content themselves with cut bait. Tackle is provided for the use of the customers. The fare for half a day or a day is \$1.50 or more.

The boats are 35 to 60 feet long and are of the same general build as similar sized commercial fishing boats. (See Fig. 70.) In fact, some of them engage in commercial fishing during the winter when sport fishing is at its poorest. They carry bait tanks which are supplied with running water. The tanks are for the live bait. The crew consists of 2 or 3 men.

Early in the morning the boats go out and catch the bait, consisting of small sardines, smelt, anchovies, queenfish, and other species. The young fish are generally found close to shore in shallow water off the sandy beaches. The boats carry round haul nets with which they catch the bait. For a brief description of this type of net and its use, see page 98.

The boats fish on the well-known banks near shore, usually in the vicinity of extensive kelp beds. Barracuda, rock bass, bonito, rockfish, sheepshead, halibut, yellowtail, and mackerel are the fish most often caught. Of these, the mackerel are the most abundant and they alone can be depended upon the year around.

The tackle provided by the boatman consists of a 10- to 18-foot bamboo pole equipped with a short heavy cotton line, a Japanese gut leader and a single hook. Many anglers take their own tackle, usually a rather heavy 7-foot rod and double action reel. Some use light rods and give the fish a chance to fight, but there are usually so many fishing that it is necessary to haul the fish right in to avoid serious tangles.

Chum, in the form of scoopfuls of live bait, is thrown into the water to attract the fish. The unweighted bait is allowed to swim about on a slack line until it is taken by a bonito, mackerel or whatever happens along.

The angling boats account for a great many mackerel and can be considered as an important factor in the sport mackerel fishery. The live bait boats' chief economic importance lies in the fact that they destroy vast quantities of young fish which they use as bait. The dozens of these boats daily take tons of fish that have not started to reproduce and which would provide many more tons of human and fish food if left to live and breed. On the other hand, the boats furnish recreation for many people and a livelihood for others besides being a contributing source to our food supply.

Barge Fishing

The fishing barge is the largest contributing factor to the sport mackerel catch of California. Thousands of people fish from the barges every week, winter and summer. Practically everyone catches 3 to 15 mackerel in a day and many times the catch is larger. The barge-caught mackerel are nearly all full grown fish of a pound and a half or more so that a very few fish make a good heavy mess to take home.

A few years ago the fishing barges were all exactly what the name implies—flat-bottomed, square-ended barges with level decks scarcely

5 feet above the water. Of late years, many of the real barges have been supplanted by the dismantled hulls of old steel and wooden sailing vessels. The hulls are roomier and more seaworthy but their decks are high above the water so that fishing is not quite as much sport. It requires a rather heavy line to hoist a large fish some 15 feet above the surface. The original type of barge is still in use at Point Mugu, Avalon and Huntington Beach, and one of the barges at each of the following places is a counterpart of the old-timers—Newport, Laguna Beach, San Diego, and San Pedro.

The barges are anchored half a mile to three miles offshore, usually in the vicinity of kelp beds. Motor launches, locally known as water taxis or speed boats, run on regular schedules between the barges and the closest town. The fisherman pays a fare, varying from \$0.50 to \$2.50, which entitles him to round trip passage, bait and the use of poles and lines. On some of the barges provisions are made for night fishing. Mackerel bite well enough in the daytime but some other species are better caught at night. Most of the barges have fountain and restaurant service and some provide sleeping quarters.

The tackle furnished for mackerel fishing consists of a long bamboo pole with a heavy cotton line of approximately equal length. A half-ounce sinker and a single hook complete the outfit. Some fishermen use their own trout or black bass rods but the height of the deck makes it necessary to drop the light rod and haul the fish up hand over hand. The long poles are sufficiently sporty although they are somewhat heavy to hold. Some mackerel are caught on hand lines or heavy rod and reel outfits, the use of which enables the fisherman to sink his bait to some depth. Usually, however, mackerel run near the surface where the long pole rigs can reach them. Some barges furnish live bait which is kept in a bait tank on the deck or in a floating receiver alongside the barge. The bait fish are supplied by the live bait boats that the barge operators often run in addition to their barge. Usually the barges supplying live bait charge more for a day's fishing than the others. When live bait is not available, pieces of salt or fresh mackerel are used.



FIG. 71. A southern California pleasure fishing barge, an old sailing vessel shorn of its masts. Note the numerous long bamboo poles that are used for mackerel and bonito fishing. Photograph by author, September, 1931.

In fine weather the barges are usually crowded. On Sundays and holidays it is next to impossible to find enough space along the rail to edge in and wet a line. From shore, the hundreds of long poles extended out the sides give the dismantled hull the appearance of an ancient Roman galley with its banks of oars.

The mackerel strike in schools. For a while all is quiet, no one catches a thing. All at once everyone on one side of the barge starts hauling in mackerel. Great excitement prevails as the struggling fish rain down on the deck. Lines break or get tangled with each other. Joyous and angry shouts mingle as some of the crowd get fish and others get tangles. After a while, ten minutes to an hour, the run suddenly comes to an end and all is rather quiet for some time until the next run comes.

Other fish are caught, to be sure, but without the never-failing mackerel the barges could not operate.

HORSE MACKEREL AND SPANISH MACKEREL

As a sport fish the horse mackerel is unimportant. This species is nowhere as abundant as the Pacific mackerel and is never the subject of special fishing effort. It is taken in small numbers incidental to the capture of mackerel, bonito and other fish of similar habits. The young are often taken by pier fishermen. The horse mackerel is a fine game fish for its size and would undoubtedly be very popular if it were more abundant. Many people would rather catch and eat it than the Pacific mackerel.

The Spanish mackerel or sierra seldom ranges as far north as San Diego. The anglers who fish in Lower California waters prize this fish and claim that it is one of the gamest fish in the world as well as being unequalled in flavor. They catch it by trolling with feather jigs or metal spoons or by still-fishing with live bait.

SUMMARY

California sport fishing is world-famous. One of the least publicized but most often caught sport fish is the mackerel. From Santa Cruz south to San Diego, nearly everyone who fishes in salt water catches mackerel—as game a fish as swims.

Monterey Bay pleasure fishermen catch mackerel from small boats that take out passengers daily from Santa Cruz and Monterey.

From Santa Barbara south, anglers can catch mackerel from any of the 27 piers, from private boats, from 30 live bait schedule boats, or from the 29 anchored barges. Nearly every seaside town has facilities enabling anyone with a dollar or so to fare forth and catch a sackful of fish—if he can.

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IX. THE MACKEREL FISHERIES OF THE WORLD

THE MOST IMPORTANT MACKEREL FISHERIES

The foregoing pages have given some idea of the importance of the California mackerel fishery, the fishing and handling methods employed in the industry and the utilization of mackerel in California. The California fishery, however, is not the only one of major importance. Japan, Norway, France, Great Britain, Canada, New England, and several other places have mackerel industries that are the equal at least of that of California.

Mackerel in quantity is sold fresh in all the maritime nations of Europe, North Africa, Japan, eastern Canada and United States, and to a lesser extent in Australia, New Zealand, South America, and some of the countries of Asia.

Salted mackerel is produced in most of the above mentioned places. Norway, Sweden, Ireland, and the eastern United States are the most important packers of this product.

Mackerel is canned, although not on a very large scale, in France, Norway, Italy, Massachusetts, and Russia on the Black Sea.

The amounts of mackerel caught in the various countries of the world are shown in Table 1. It will be seen that the east coast of the United States, Canada, France, Great Britain, and Japan are the leading producers along with California. The fisheries of these countries are described briefly in the following pages to afford a comparison with that of California. The fishery of Canada is so similar to that of New England that no separate discussion is necessary.

THE UNITED STATES ATLANTIC MACKEREL FISHERY

History²⁶

The colonization of New England was made possible because of its fisheries resources. The first explorers encountered great numbers of fish of various kinds and their reports induced European fishermen to make the trip across the sea. The earliest attempts at colonization were made by fishermen. The pilgrims and other colonists could not have survived the first rigorous winters without the fish and shellfish they found in abundance.

The fish that first attracted European fishermen was the codfish. Salted codfish was from the first the most important fisheries product of New England and held that position for many years.

The great schools of mackerel that visited the New England coast every summer were exploited to some extent as early as 1626. During the seventeenth century, the mackerel was used principally as bait. During the first part of the eighteenth century, the New Englanders began to salt mackerel for export to the West Indies, where it was used to feed the negro slaves. The mackerel fishery remained unimportant

²⁶ McFarland (1911) provides much of the historical material.

until after 1815. Boston was the leading mackerel port during colonial days.

From 1819 to 1831, the fishery underwent a steady growth. Mackerel had become a popular article of diet and many boats were fitted out to supply the new market. After 1831, a decade of decline followed to be succeeded by several good years. Since its inception the mackerel fishery has been subject to great fluctuations due to the unfathomable habits of the fish and because some spawning years have been extremely successful, providing plenty of fish, whereas in other years the spawning has been almost a total failure. Until the Civil War, Massachusetts, led by Boston, was the leading mackerel State. Maine was second in mackerel landings, with Portland and Eastport the centers.

At the time of the Civil War, fish of all kinds was in great demand and the mackerel swept to the fore in supplying the market. During this period, the mackerel was the most valuable fisheries product of the country. At this time Gloucester became the leading mackerel port, a position which it has held or shared with Boston to the present.

The mackerel fishery dwindled to a mere shadow of its former glory during the last few years of the nineteenth century due to a continued scarcity of fish and did not revive for some time. At present (1931) it is one of the most important of the Atlantic coast fisheries with an annual yield of 30 or 40 million pounds.

Several attempts to exploit foreign waters for mackerel have been made by New England schooners. They penetrated into the Gulf of St. Lawrence as early as 1830 and were so successful as to continue the practice. A number of international disputes have arisen over the Gulf mackerel fishery. In 1878 an attempt at purse seining in Norwegian waters was made by a New Englander. He caught but few fish as the mackerel seemed to run in very small, wild schools. During the years 1889 to 1891, a New England seiner operated off the coast of Africa. The first season was a success but adverse legislation and lack of fish caused the owners to suspend activities. In 1899 a New England schooner had a fair season off Ireland and shipped some mackerel home but the vessel was wrecked before returning. Since then, to the best of our knowledge, no expeditions to waters more distant than the Gulf of St. Lawrence have been made by American mackerel schooners.

Fishing Methods

Before 1816, the usual method for catching mackerel was by "bobbing" from a small boat. The fishermen used a 7-fathom white hempen line to the end of which a boat-shaped lead sinker was fastened. A hook was attached to the weight by a 1-foot ganging.

In 1816, the jig was invented. Lead was run around the hook itself to make the lure. The jig was drawn up and down in the water for the fish to strike at or be snagged. Ground-up fish, called toll bait (known as chum in California), was thrown into the water to attract and excite the fish. The bait mill for grinding the bait came into use about 1820. Before that the fish were chopped up with hatchets or pounded with mallets. The original method was for the fishermen to grind the fish on deck under the heels of their heavy boots.



FIG. 72. The mackerel schooner "Sunapee" of Portland, Maine. Photograph courtesy of "Fishing Gazette," New York.

Hook and line remained the standard and accepted gear for mackerel until about 1870. At this time the use of the purse seine became widespread. A few seines were in use before the Civil War but it was not until the early seventies that this type of gear became popular.

A number of types of gear are in general use today. The purse seine is the most important, followed by the gill net. Both of these types of nets are fished from large schooners. In addition to the vessel fishery there is a rather extensive shore fishery in which pound nets, traps, weirs, gill nets, and lines are utilized. The traps, weirs and pound nets are fixed types of gear that are tended by small boats. The gill nets and lines are fished from small boats.

Since the invention of the schooner in 1713, that type of vessel has been the standard for east coast codfish and mackerel fishing. Many improvements have been made during 200 years of schooner construction, but the two-masted mackerel vessel of today is not remarkably different from the two-master of the early eighteen hundreds. (See Fig. 72.) In 1900 the first auxiliary engine was installed in a mackerel schooner. Before that time sail was depended upon entirely. All the vessels of today are equipped with oil engines to supplement their sails.

Hundreds of fine schooners, nearly all New Englanders, are engaged in the mackerel fishery of today. The seiners and netters are similar except in size. A typical purse seiner is about 110 feet long over all, and a gill netter is 75 or 80. The vessels must be large enough to carry a crew of 5 to 15 men (depending on the type of gear), several small boats, nets, and sufficient food and ice for a trip of a week or more. During the off-season the vessels long-line or drag for haddock and similar fish.

The season begins in April off the coast of New Jersey and Virginia. The Boston, Gloucester and Portland schooners engage in the spring fishery and sell their catches in New York. Later in the year the fishery is extended as far north as Nova Scotia. The New England vessels then fish near their home ports and deliver their fish at Boston and Gloucester. Canadian fishermen engage in the summer fishery, landing their fares in the various ports of the maritime provinces.

An interesting account of the operations of mackerel schooners appeared in the June and July, 1926, issues of *Fishing Gazette*. The author was Gerald Fitzgerald, fisheries engineer for the United States Bureau of Fisheries. The following notes are largely drawn from his article, which is divided into two parts, one dealing with the operation of a netter and the other describing a trip aboard a seiner.

Gill netting the mackerel is something of a gamble. It is difficult to see mackerel except on the darkest nights, at which time the phosphorescence betrays their presence. The "fire" is an aid to the seiner but a hindrance to the netter as it shows the gill net as a curtain of light which the fish avoid. Hence it is necessary for the netter to fish during full moon periods by guesswork or to set his nets at dusk or dawn, at which times the mackerel have the habit of breaking water or "sticking their heads out of water," as the fishermen call it.

The simple mackerel gill net is 26 to 28 fathoms long and hangs 18 to 19 feet deep. The size of mesh is usually $3\frac{5}{8}$ or $3\frac{3}{4}$ inches, stretched measure. The dimensions as given are before tanning, a preservative measure that shrinks the netting a little. Seventy corks of $3\frac{1}{2}$ inches diameter are strung along the top at intervals of 24 to 30 inches. Six pounds of lead weights, each one-sixth of a pound, are strung along the lead line. The nets when fishing are tied end to end, making a "string" about $4\frac{1}{2}$ miles long, usually composed of 114 nets. The nets are worth about \$15 each and are made at Gloucester. They last three or four seasons.

The strings must be set parallel to the shore, otherwise they will be across the path of coastwise steamers which care nothing about running through and destroying a net. This destruction is one of the greatest grievances of the netters. As the course of the schools of mackerel is usually along the shore, it is a handicap to have to set the nets parallel to the coast.

At each end of the string and in the middle is a flag buoy. Between the end and second nets is a buoy with a light. Other light buoys are placed at intervals of 16 nets, the number hauled by each dory. It requires about an hour and a half to set a string.

The schooner crew is composed of 5 or 7 men, 2 to each of the 2 or 3 dories, and one other who stays on the vessel. Each dory hauls its string of 16 nets and then returns to the vessel to unload the fish obtained. It then hauls its next string. During full moon the nets are left out all night. It requires 3 to 5 hours to haul a complete string in calm weather. Spiny dogfish often get fouled in the nets, requiring a great deal of labor to pull them loose.

The seiners are similar to the netters in construction but are usually larger. In order to handle the bulky purse seine, a crew of 12 to 15 or more is necessary. The seiner carries a 15-foot dory and a double-ended open seine boat of 38 to 40 feet, both of which are used

in fishing the seine. The purse seines are somewhat similar in construction to the ring nets of California. (See pp. 62-65.) They vary in length from 200 to 230 fathoms on the cork line. The lead line is 30 to 40 fathoms longer than the cork line. The depth of the nets is 22 or 23 fathoms. The mesh in the wings is $2\frac{1}{4}$ to $2\frac{1}{2}$ inches, stretched measure. The webbing in the central portion is of 2- or $2\frac{1}{8}$ -inch mesh. The bunt or brailing piece is of the same size mesh but is made of heavier twine. The corks are 4 or $4\frac{1}{2}$ inches in diameter, strung about 12 inches apart. The leads are one-sixth of a pound each and are placed at intervals varying from 6 feet at the dory end to 3 feet at the seine boat end of the lead line. About 27 five-pound purse rings are strung along the bridle line at 5-fathom intervals. This type of net would tend to purse too near the surface, so after it has been circled and the ends made fast to the seine boat, 95-pound lead weights are run down the purse lines before pursing is commenced. The combined weight of leads and rings is about 200 pounds, exclusive of the pursing weights. A California purse seine of approximately the same size carries more than 1000 pounds of lead so that pursing weights are not necessary.

Seining is carried on at night when the presence of schools of fish is betrayed by the "fire" that their movements through the myriads of luminescent organisms in the water cause. During the periods of full moon, the light is strong enough to obscure all luminescence so the seiners confine their activity to the dawn and the twilight when the mackerel show themselves by breaking water.

When on the fishing grounds, the seine boat and dory are towed behind the schooner, the net piled in the seine boat. As soon as the lookout sights fish, two men get into the dory and all the rest of the crew except a wheelman and the captain get into the seine boat. The captain maneuvers the vessel into position, and the dory, fastened to one end of the net, is cast loose. The men in it hold their position with the oars. The schooner tows the seine boat around the school while the men in it pay out the net. Until quite recently, it remained the practice to row the seine boat around the circle while the schooner stood by. After completing the circle, the seine boat is dropped and both ends of the net are made fast to it. The dory, which has given over its end of the net to the boat, transfers the captain from vessel to boat. The bottom of the net is pursed together with the aid of a power winch and the rings are brought aboard. Then the wings are hauled into the boat so that the fish are concentrated in the bunt. The vessel comes alongside and "bailing out" commences. To support the weight of the fish confined in the bunt, a portion of the cork line is put over the vessel rail; the rest of it is held up by the dory and the seine boat. "Bailing out" or brailing is accomplished by means of a power dip net. As much as 30 or 35 tons are sometimes taken in a single seine haul, but such catches are the exception rather than the rule. After each haul, the seine must be hauled aboard the vessel, repiled and taken into the seine boat again. This operation alone consumes an hour.

Once on board, the fish caught by either type of vessel are subject to either one of two treatments. In former years nearly all were salted down, but at present a great many are delivered fresh to the

nearest port, especially during the early spring when other fresh fish are rather scarce. If the mackerel are to be salted they are split open, cleaned out, soaked several times in sea water, rubbed in fine salt, placed in barrels, and lightly resalted. For delivery fresh, the fish are placed in pens in the hold and ice is shoveled over them.

Utilization of Mackerel

Prior to 1870, practically all the mackerel consumed had been salted. About this time, as a result of the increased use of ice, fresh mackerel became popular. Hitherto it had been impossible to ship unsalted mackerel to the consumer without a heavy loss through spoilage. The first time canned mackerel was produced on a commercial scale was in 1880, although an Eastport, Maine, cannery packed some experimentally as early as 1843.

At present great quantities of mackerel are sold both salted and fresh. Salted mackerel is a famous food in the East. The demand is so great that the American fishery can not fully supply it and European salted mackerel must be imported to a considerable extent. Fresh mackerel is highly esteemed by the people living east of the Mississippi, so that during the height of the summer season large numbers are sold fresh. When the mackerel are particularly abundant, some are sharp-frozen and held until winter when they meet with a ready sale.

Small amounts of mackerel are canned at Boston and Gloucester during periods of great abundance when it is impossible to dispose of all the fish fresh. The pack is in 8-ounce and 14-ounce cans. The following table shows the production in cases during recent years:

	8-ounce (2½ to case)	14-ounce (2½ to case)	Converted to standard cases
1928-----	3,103	21,956	10,382
1929-----	----	22,473	9,832

The conversion to standard cases (48 one-pound cans to case) was made to facilitate comparison with the California mackerel pack which is put up in the standard case. (See Table 3.) The figures are from United States Bureau of Fisheries statistics.

Since 1926, the filleting of various sorts of fish has become an important part of the fishing industry of Boston and more lately of New York. Large mackerel lend themselves quite readily to this method of preparation so fairly large numbers are processed in that manner now. They meet with good sales, especially in inland markets. In preparation, the fish are beheaded, gutted and split lengthwise before wrapping in a moisture-proof vegetable parchment or cellophane package. Several packages are placed in a tin container which is surrounded with ice and packed in a wooden barrel or bucket. Filleted mackerel are shipped as far as St. Louis and Chicago.

THE FRENCH MACKEREL FISHERY

Excerpts from Corwin's review (1930) of a French paper comprise the account of the French mackerel fishery. The author discusses the

fishery under three headings: the great fishery for mackerel, the drift mackerel fishery and the small fishery for mackerel:

THE GREAT FISHERY FOR MACKEREL

At Boulogne and Fécamp (northern France) the main fishing season begins from March 15 to April 20, and at Douarnenez (western France) the end of January. The area fished extends to the coast of Cornwall and up to the Thames estuary. From September first to the middle of October the fishery is in the North Sea and is called the Thames fishery.

The sailboats carry 15 to 24 men, receiving 90 to 95 francs (\$3.60) a month, and the steamboats 25 to 30, the men receiving 100 francs (\$4) a month. At Fécamp each fisherman receives a bonus of 80 to 120 francs according to the value of his services. Besides the salary and bonus the catch is divided into shares, depending upon the position held by the man in the crew and on how much gear he furnished; for instance, a man contributing 5 double lines is entitled to a half share.

The drift nets are 30 to 32 yards long and $6\frac{1}{2}$ yards wide, of cotton, and have a mesh of $1\frac{1}{2}$ to $1\frac{3}{4}$ inches. The equipment of one boat consists of 250 to 500 nets. Several of the nets are fastened together and set at the surface with a line of cork floats at the upper edge and weighted on the lower edge by a rope attached by lines 14 yards long, the rope therefore paralleling the net 14 yards below it. The fish are caught by the head as they swim into the meshes, which are too small for them to pass on through. The steamers make seven trips during the season, and the sailboats three, the length of each trip diminishing toward the end of the season.

The fish that are to be salted are cleaned and cut twice transversely and salt rubbed into them. They are placed loose in the hold, except the small ones and those damaged, both of which are packed in barrels. The roe is also salted.

In 1888 a fleet of fishing boats was organized with tenders provided with ice, but on account of international complications this system was discontinued. At present the boats operate separately. The fish that are to be brought in fresh are packed in layers alternating with cracked ice, in wooden boxes containing 40, 80 or 110 fish, according to size.

The port of Boulogne deals in fresh fish, while Fécamp specializes in salted. Some of the drifters sell their catch at Fleetwood (the northwest coast of England), Newlyn (southwest coast of England), Ostend, Belgium, and IJmuiden, Holland. The methods of sale are various: by the case, as described above, by 110, by 100, or by weight. It appears that the fish are not canned, but are smoked or salted. The refuse is used by fertilizer factories.

THE DRIFT MACKEREL FISHERY IN BRITTANY

This fishery extends to the coast of Ireland and employs 1500 men. It is not as remunerative as the tuna and sardine fisheries, but is carried on to fill in the time between these seasons. Douarnenez is the most important port, with 75 boats called "dundeeds," totaling 3279 tons. The season starts in January or February and lasts until the sardine and tuna seasons start (the last of June). The small boats are gradually being replaced by ones of larger size and greater seaworthiness. The loss of life has been reduced 95 per cent since this improvement started. None of the boats have any apparatus for lifting the nets and all of this work is done by the men. Only four of the boats at Douarnenez have an auxiliary motor. The boats are seldom owned by one man, and rarely does the captain ("employer") own a share in the boat.

Here again the fishermen furnish the nets, supplies and ice, and the proceeds are shared accordingly. Sometimes a captain or employer will take a set of seven nets from sick or disabled sailors, widows or orphans and give them half the profit.

The nets are 1000 meshes long and 50 wide (43 by 4 yards), with $1\frac{1}{8}$ -inch mesh and the cost is 128 francs (\$5.12). To preserve them they are dipped in catechu, a brown tanning substance. When the boats come to the fishing banks the fishermen replace their masts with shorter ones and put up a trysail which causes the boat to progress more slowly. The ends and the middle of the net are marked with an acetylene lamp and the name of the boat. In the morning at 2 or 3 o'clock they begin to lift the nets. The greatest loss to the fishermen is from passing steamers. Each fishing boat makes about 10 trips a season, with 3 to 8 days per trip.

The "dundees" take ice in blocks which are placed on shelves and the fish laid on the blocks, but if the trip is to last not more than 72 hours they do not take ice.

Douarnenez is the largest market in the province of Finistere, with 25 fish dealers, 23 factories and a large refrigerating plant. Up to 1923 the fish were sold by the "baker's" dozen, but now they are sold by the hundred. The sales take place on the wharves by the auction method, except that the captain of the boat starts out with a maximum price and comes down until he finds a buyer. The fishermen wash the fish and deliver them to the buyer. The season of 1926 brought 4000 francs (\$160) per man and 16,000 francs (\$640) for the boat.

THE SMALL FISHERY FOR MACKEREL

This is carried on in Morocco, Vendée, Tunis and Algeria. At Dieppe (northern France) the season is from May to October, between herring seasons, and at Havre from July to September. Floating lines, drag lines, drift nets and seines are all used in the fishery. In certain localities when the weather is calm, set lines are used with nets paralleling them in between. For trolling the lines are of linen or horsehair with two to six hooks baited with marine worms, shrimps, herring, cod tails, or the first mackerel that was caught. Even pieces of red cloth or bits of rubber are used with success. At Bône, Tunis, they use straw or white cloth. On the Moroccan coast they use a piece of corn husk on the barbless hooks. Each boat has several lines each weighted differently in order to place it at a different depth. In some localities a basket of fish refuse is lowered into the water to attract the fish to the spot. In Provence linen lines are used with a wire leader and a one-pound sinker from which hangs a series of hooks baited with crabs. Sometimes a bright shiny spinner with a triple hook is used. The Brittany fishermen usually employ a horsehair line with one hook, baited with mackerel. A good catch is 1100 pounds for the smaller boats, or 1700 to 2000 pounds for the larger.

Pole fishing in the Mediterranean starts with "chumming" or attracting the fish with a meal composed of sardines, herring, beef or mutton spleen, bran, cheese and asafetida.

The "turlutte" is an interesting piece of gear resembling the handle of an umbrella with just one rib on which are soldered several hooks. The fish are "chummed" and the apparatus is dragged through the school to snag the fish. This method has been outlawed in some localities because it tears the fish. The "scoumbrière" used in the vicinity of Marseille (Mediterranean coast) is a trammel net of horsehair 40 to 70 fathoms long and widens from 70 to 100 meshes. The lower line carries only five leads to a fathom, while the upper line has a float every two feet. This net consists of three layers or curtains: the two on the outside are of large size mesh and the one in the center of small mesh. The fish pass through the large mesh and shove the small mesh (through which they can not go) on through the third layer of net and in their efforts to push through entangle themselves. At Marseille the fishermen string together 10 nets of 70 fathoms length, or 30 of 40 fathoms. The ends of the net are made of linen, with a rope attached. They are laid in the same way as the drift nets mentioned above, by a boat using a try-sail. The season for using this gear is from March to July when the sea is rough. This type of gear is characterized as "very effective," bringing in over half a ton a day. * * *

A cone net, 2 feet in diameter, mounted on a wire hoop with $\frac{1}{2}$ - to $1\frac{1}{2}$ -yard handle, is used successfully by some of the fishermen of Douarnenez.

The expenses and profits are placed on a share basis as in the other fisheries described. The fish are sold in some places "by the tail," by twos, by the whole lot in the catch, by 100 or 1000, or by weight. In most of the northern parts the fish are sold by auction.

Increasing amounts of mackerel are being canned in oil or pickled in white wine. The mackerel of 4 to 5 inches are usually canned whole in olive oil, and the process is much the same as that used for the sardine.

An interesting custom in Sud-Finistere allows the fishermen using the set lines to go fishing for themselves Sundays during the month of October.

In spite of the fact that the French mackerel fishery is traditional and slow to adopt new methods, it is one of the most important fisheries of the world and provides a living for thousands of fishermen and distributors.



FIG. 73. Sailing drifters setting out for the fishing grounds from Looe, Cornwall. This type of boat was used extensively in the English mackerel fishery before the Great War. Photograph courtesy of Ministry of Agriculture and Fisheries, London.

THE BRITISH MACKEREL FISHERY

The mackerel fisheries of England, Scotland and Ireland have been of great importance since the fifteenth century and perhaps earlier. The famous race to get the first mackerel of the season to London has been carried on for centuries.

Six types of gear account for the British mackerel catch. These are gill nets, tuck seines, purse seines, weirs, hand lines, and long lines.²⁷

The drift gill net is the most important. The nets are fished in "fleets" or strings, very much as the French nets are. Before the World War, small motor and sail drifters fished the gill nets for mackerel (See Fig. 73), but lately these boats have been replaced by larger and more seaworthy diesel and steam drifters.

The English tuck seine is an encircling net used to some extent in mackerel fishing. This seine is shaped like a large curtain made of webbing, coarse meshed at the ends and fine meshed in the middle. There is a cork line at the top and a lead line at the bottom to keep the net hanging vertically in the water. The dimensions of a tuck seine are approximately 200 x 8 fathoms. The net is circled about a school of fish by a small boat, after which the wings are hauled simultaneously into a larger boat so the fish are concentrated in the fine meshed central portion. The lead line is shorter than the cork line so that when circled there is a "floor" of webbing under the fish to prevent their escape by sounding.

The purse seine or ringle tingle seine is also employed in the mackerel fishery although to a limited extent. It is similar to the tuck seine with the addition of a series of iron rings along the lead line,

²⁷ Descriptions of British fishing gear are taken largely from Davis (1927).

through which a purse line is run. When the net is circled about the school of fish, the ends of the purse line are run through rings in a 300-pound "tom-weight" which is sunk to the bottom. The weight keeps the lead line down. The purse line is hauled upon, drawing the rings and lead line together under the fish, preventing their escape by diving. The tuck seine is comparable to the California lampara which is described on pages 98-99, and the ringle tingle net is similar in effect, if not in operation, to the California ring net and purse seine which are described on pages 62-65, 72-73.

Long lines are of some importance in the British mackerel fishery. This type of gear consists of a line bearing several hundred hooks placed at regular intervals and fastened by snoods of twine, wire or gut. The hooks are baited with pieces of mackerel or sand-eels, natural fish baits, rag worms, or bright artificial baits. The lines are set at the desired depth and hauled at suitable intervals.

Some fishermen troll baited hand lines behind moving boats to catch mackerel. This method of fishing is known as "whiffing" or "railing." Sometimes one line is used, but more often several are employed. They are kept clear from each other by trailing them from outriggers and by using sinkers of different weights on adjacent lines. Sometimes bright metal spinners armed with triple hooks are employed to good effect in place of bait.

At several places along the coasts of the British Isles there are stone, brush or netting fish traps or weirs, some of which are of ancient origin and some of which are comparatively new. The weirs were not built especially for catching mackerel but numbers of that fish are captured along with the rest. Weirs are so constructed and placed, either along the shore or in estuaries, that they trap at ebb tide those fish that have gone close inshore during the high tide.

THE JAPANESE MACKEREL FISHERY

History

It is difficult to appreciate the vast importance of the fisheries of Japan. Hundreds of thousands of fishermen guide their boats along the lengthy coast line of the islands and travel to distant banks in an effort to appease the enormous fish appetite of the Japanese people. All kinds of fishes in ever increasing numbers fall victim to a variety of gear ranging from the most primitive dip nets and spears to modern power trawls.

The mackerel is one of the leading commercial fish of the empire. Every year over 150,000,000 pounds of mackerel are known to be caught by Japanese fishermen.

Kishinouye (1923, pp. 394-395) tells us that mackerel fishing has been carried on in the waters of the Japanese islands since the Stone Age. Bones of the mackerel are frequently encountered in the ancient shell mounds in different parts of the empire. The fish were probably caught on baited hooks because barbed hooks made of antler and of the right size for mackerel and similar fish have been found in the same shell mounds.

There was a fishery for mackerel in early historical days, as can be seen from the following sentences in Kishinouye's paper. "In the 'Yengishiki,' a classical work compiled between 900-927, we find names of several kinds of food prepared from the mackerel and striped bonito. These products were paid as tribute to the imperial court and the government from several provinces round our coasts." The root name "saba," Japanese for mackerel, is from the ancient language of the country.

Fishing Methods²⁸

The range of the mackerel is from Karafuto (Sakhalin) to Taiwan (Formosa). It is found in water of depths up to about 50 fathoms in a temperature of 10°-20° C. The fishing seasons are different in the various parts of the empire. In the spring the mackerel enters the Inland Sea, and in the summer it is taken off the west coast of Karafuto. In the winter it is caught near Tanegashima and Kagoshima in the southern part of Japan proper. In Hondo, the principal island of Japan, it is taken all year with largest landings in the summer and autumn. At the channel of Chosen, the southern entrance to the Japan Sea, the mackerel schools appear in the spring and autumn.

Japanese mackerel fishermen carry on five kinds of hook and line fishing and three kinds of net fishing. The types of lines are rod and line, casting line, troll line, ordinary hand line, and long line—the last two being the most important. The types of nets are haul seines, drift gill nets, and encircling nets such as the purse seine and the "shibari-ami."

The long line is a drift line, suspended from floating barrels by means of buoy lines, and is sometimes equipped with light weights. The numerous hooks of these lines are baited with small pieces of sardine, horse mackerel or mackerel.

The hand line is extensively used. It consists of a line, about as long as the depth at which the fish are to be found, at the end of which there is a conical sinker one-half to one pound in weight. Two brass outriggers or spreaders, each about one foot long, extend horizontally from opposite sides of the sinker. A worm-gut snood, 6½ feet long, with a small hook at the distal end, is fastened to the end of each spreader. The outriggers permit the use of two hooks without fouling. A small bag containing toll bait to attract the fish is fastened to the sinker. Most of the fishing is done at night. The fishermen light torches or acetylene lamps which not only attract the mackerel toward the boat but also lure smaller fish and other animals whose presence in turn is an attraction to the voracious mackerel.

Drift gill nets are used in the warm season, especially in the Japan Sea. They are suspended in fairly deep water by means of long buoy ropes. The drift nets are worked at night.

Immature or yearling mackerel are caught with haul seines in shallow water near shore. In the southern part of Chosen (Korea) encircling seines are largely used. Some mackerel are also taken in weirs.

²⁸ The following description of fishing seasons and gear was compiled from Kishinouye (1923).

Utilization of Mackerel

The Japanese people relish the mackerel in a fresh condition and a large part of the catch is consumed without being processed. However, large quantities are dried and salted, and the manufacture of fish cakes from mackerel is an important industry at many ports.

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X. THE CALIFORNIA MACKEREL FISHERY SINCE 1931

Since the completion of the foregoing report there have been several developments of interest in the California mackerel fishery. These are reviewed below.

DURING 1932

The California mackerel catch for 1932 was 12,473,556 pounds, a drop of nearly two million pounds from the 1931 total. The landings at all the principal ports decreased. Monterey deliveries dropped to 665,000 pounds, a loss of nearly 50 per cent. The San Pedro catch amounted to 11,500,000 pounds, a decline of about one million pounds from the previous year. Newport, with 108,000 pounds, reported the smallest catch in ten years. The San Diego total of 178,000 pounds was slightly below the 1931 catch. (See Fig. 17.) The decline from the previous year was due entirely to a diminished demand at the fresh fish markets, as the San Pedro canneries took about as much mackerel as they did in 1931. A total of 88,765 standard (48-pound net) cases of mackerel was packed. (See Table 3.) All of this was canned in Los Angeles County with the exception of 184 cases packed at San Diego. The output of canned animal food made from mackerel increased to 59,600 standard cases. Some of this was packed in 6- and 8-ounce cans. The number of active canneries remained the same. The one plant in San Pedro proper moved its machinery to an idle plant on Terminal Island.

Prices paid to the fishermen were very low throughout the year. The markets paid from one-half to two cents per pound, and the canneries dropped their price to \$8 per ton. The canners received as low as \$2.15 per standard case.

Horse mackerel landings at Monterey dropped to about 50 per cent of the 1931 figure, but the Los Angeles landings showed a substantial increase. The Monterey catch was 120,500 pounds and the Los Angeles catch amounted to 416,000 pounds. With the addition of a few fish from other districts, the State catch totaled 537,685 pounds, a drop of but 25,000 pounds from the 1931 total. (See Fig. 16.)

DURING 1933

The canned mackerel industry underwent a sudden expansion in 1933. The prices of the competing grades of salmon advanced, and there was a shortage of canned sardines to fill an increasing demand for canned fish. As a result, orders poured in from the Philippine Islands and more particularly from the southern and midwestern states of this country.

Mackerel were scarce from January until near the end of May, but during June and July the canneries took nearly 20,000,000 pounds. The first seven months of the year far exceeded all of either 1931 or 1932, and the future of the industry looks brighter. The greatest danger

to the industry lies in the possibility of over-production which can result in flooding the market and may bring about depletion of the supply of mackerel. Six canneries at San Pedro have been taking fish from a fleet of about 75 boats, paying \$10 per ton. Two canneries at San Diego have been packing mackerel in quantities, and two at Monterey have been operating on a smaller scale. The price of canned mackerel has advanced to \$2.50 and \$2.75 per case. In addition to the usual pack in 16-ounce tall cans, there has been considerable production of 8- and 12-ounce tall cans, a greater proportion of the output being so packed than ever before.

The increased demands of the cannery for fish, coupled with the generally poor state of the fresh fish market, have led a number of hook and line boats to reenter the mackerel fishery. At San Pedro, where there had been no cannery hook and line fishing since early in 1930, six live bait boats have become regular participants in addition to a number of other hook-and-liners that fish occasionally. Their method of fishing is the same as described on pages 74-76. These six boats also employ a type of gear new to the mackerel fishery—the dip net. This consists of a hoop net of coarse chicken wire netting on a long handle. The fishermen attract the mackerel to the surface at the side of the boat with live bait, and then make a swoop into the closely packed mass of fish, reputedly catching as much as 30 pounds at a time. Several regular ring net boats removed their nets and fished with hook and line at times in order to exploit the mackerel in Santa Monica Bay, where nets are illegal.

During the period under discussion (summer of 1933), gill net fishermen, while fishing for barracuda, seemed to catch more mackerel than usual. As a result, a half dozen gill net boats made fairly consistent deliveries of small loads to San Pedro canneries all summer. Their nets are made of 3 $\frac{3}{4}$ -inch mesh and catch fairly large mackerel to the exclusion of small ones. It is reported that the gill-netters circle the schools of mackerel and then scare the fish toward the net in which they become entangled, but the majority of the mackerel are probably caught incidentally with the barracuda.

During the early summer when mackerel were scarce and would not readily rise to the "hamburger" chum (see pp. 65-66), some of the ring net fishermen installed bait tanks and used live anchovies and sardines as chum. (See footnote 16, p. 66.) Several San Pedro boats too small to carry bait tanks employed "chum boats." These are small live bait boats that chum the mackerel into a compact school which the net boat encircles. As soon as the net has been pursed, the chum boat leaves the circle by passing over the cork line. The net fishermen give the chum boat one-third of the catch as its share.

The usual method of fishing with ring nets and employing chopped fish as chum (see pp. 65-72) still supplies the canneries with the bulk of their mackerel as in the past several years.

August 1, 1933.

DIVISION OF FISH AND GAME OF CALIFORNIA

BUREAU OF COMMERCIAL FISHERIES

FISH BULLETINS

- * No. 1. Report on Fish Conditions. 1913; 48 pp., 3 figs. Contains:
 The Abalone Industry in California. By Charles Lincoln Edwards.
 The Towing of Salmon and Steelhead Fry from Sacramento to the Sea
 in a "Live Car." By N. B. Scofield.
 The Problem of the Spiny Lobster. By Bennet M. Allen.
 Investigation of the Clams of California. By Harold Heath.
 Investigation of the Life History of the Edible Crab (*Cancer magister*).
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 Trout and Black Bass Planting and Transplanting in the San Joaquin
 and Southern Sierra Districts. By A. D. Ferguson.
- * No. 2. The Scientific Investigation of Marine Fisheries as Related to the Work
 of the Fish and Game Commission in Southern California. By Will
 F. Thompson. 1919; 27 pp., 4 figs.
- * No. 3. The Spawning of the Grunion (*Leuresthes tenuis*). By Will F. Thomp-
 son, assisted by Julia Bell Thompson. 1919; 29 pp., 9 figs.
- * No. 4. The Edible Clams, Mussels and Scallops of California. By Frank W.
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- * No. 5. A Key to the Families of Marine Fishes of the West Coast. By Edwin
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- * No. 6. A History of California Shore Whaling. By Edwin C. Starks. 1922;
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- * No. 7. The Life History and Growth of the Pismo Clam. By Frank W. Wey-
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- No. 11. The California Sardine. By the Staff of the California State Fisheries
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